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THE IMPORTANT PARASITES, PREDATORS, AND ASSOCIATED INSECTS OF THE MOUNTAIN PINE BEETLE IN WESTERN WHITE PINE

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Respectfully submitted,

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INTRODUCTION

The following report deals with a study of some of the parasites, predators of, and other insects associated with mountain pine beetle in western white pine in the region of Metaline Falls, Washington, on the Kaniksu National Forest, between April and September, 1930.

The results of the study show:

(1) That before a method can be devised for the preservation of the beneficial insects during control operations, a good deal more information is needed on the seasonal history of the mountain pine beetle as well as its parasites.

(2) That indications are that control operations in the fall of the year as recommended for lodgepole pine would probably do little good in the western white pine stands, owing to a variation in the seasonal history of the beetles and its parasites.

(3) That the same species of beneficial insects which are important in lodgepole pine are present in western white pine with but few exceptions.

(4) That in spite of the number of species of insects destroying the mountain pine beetle, it continues to flourish.

The most important group of insects, the Hymenoptera are dealt with first; the group second in importance, the Diptera, next; and the

group of least importance, the Coleoptera, last.

As practically all of the insects occurred in western white pine that were found in lodgepole pine, the first 5 plates are the same as those used for the previous report (1). All the insects shown in the plates are not mentioned in the text, however. For a record of their occurrence in western white pine, see the supplementary annotated list (2).

A bibliography dealing chiefly with the more important papers on parasites and predators will be found at the end of the report.

ACKNOWLEDGMENTS

Mr. W. D. Bedard and F. B. Foley assisted in the field work at various times during the study. All photographs were made by Mr. H. J. Rust of this station.

(1) DeLeon, D. The Parasites, Predators, and Associated Insects of the Mountain Pine Beetle (Dendroctonus monticolae) in Lodgepole Pine. Station Report 1930.

(2) DeLeon, D. An Annotated List of the Fauna Associated with the Mountain Pine Beetle in Western White Pine and Lodgepole Pine. 1931.

Coeloides sp.

(Hymenoptera - Braconidae)

Coeloides sp. was found to be the most important parasite of Dm in white pine as it was of Dm in lodgepole pine. However, the distribution of the larvae of this parasite in infested white pine trees is not as even as it is in lodgepole. This unevenness of distribution in the white pine type appears to be caused by the spreading out of the Dm attack over a period of several months, so that there is no period during which full-grown or nearly full-grown larvae predominate. Thus, a special time for artificial control cannot be given.

DESCRIPTION OF STAGES

ADULT

Coeloides sp. (Plate 4, fig. 1e) is a small wasp-like insect. The females average about 5.5 mm. in length including the ovipositor. The male parasite is seldom over 4 mm. in length. While actual measurements of mounted material show that there is very little difference in size between those bred from Dm in lodgepole and those from Dm in white pine, the impression, when one sees the living insect, is that the average size for those from white pine is distinctly greater. The color of the parasites from Dm in the two host trees is the same. The head and thorax of both sexes is black; the abdomen of the female is generally red or reddish, that of the male black. Occasionally, however, one finds a female with a black abdomen or a male with a reddish abdomen.

Note: Throughout this report the convention has been adopted, as a convenience, of using "Dm" to represent Dendroctonus monticolae Hopk. Where the abbreviation is followed by a number it gives the year of attack; thus, Dm '30 W.W.P. means a western white pine attacked by D. monticolae in 1930.

EGG

The egg (Plate 4, fig. 1b) is pearly white in color and an elongated oval in outline. The average length is about 1.2 mm. The egg is somewhat larger at one end than the other; frequently with a slight curve at the smaller, and the surface is smooth and somewhat shining.

LARVA

The first instar larva (Plate 4, fig. 1c) is approximately the same size, shape, and color as the egg from which it emerges. As growth progresses the larva becomes plumper, filling out until it attains the shape shown in Plate 4, Fig. 1. The head is smooth and bears a brownish sclerotized design around the buccal cavity as shown in Plate 4, Fig. 1a; the single-jointed antennae are set in relatively large, shallow circular depressions. The remaining body surface of the larva is entirely covered with minute bristles while the terminal segment also bears a few long slender hairs. The full-grown larvae average 4 to 6 mm. in length.

PUPA

The pupa is creamy white and somewhat longer and more slender than the mature larva. The female has the ovipositor turned back over the abdomen. Pupation normally occurs within a silken cocoon which may vary from tan to nearly pure white. The cocoons (Plate 6, fig. 1) range from 4 to 8 mm. in length.

SEASONAL HISTORY

Because of the overlapping of Dm development and parasitism by *Coeloides* sp., the brood of the beetle and the parasite in each "type" of

infested tree will be followed through separately. It should be remembered that the types described below show the condition at Sullivan Lake, unfortunately for the past summer only, and that the conditions there may vary from year to year and also with the locality. It is believed that the variations which may develop will be in detail and not in fundamentals.

TYPE 1. The first Dm attack of the season occurs in June but the attacks are small in proportion to the number of attacks occurring in July and August. The brood of this attack developes rather rapidly and by the first week in July some of the brood is well enough advanced for parasitism by Coeloides. By the end of July most of the brood is well developed and by the middle of August most of the brood is in the pupal stage. Towards the end of August many of the callow adults are present and of these over half emerge before the middle of September; the remainder stay under the bark until the following spring. The parasites begin laying eggs on the Dm larvae in this type of tree about the first week in July; parasitism continues until the brood of the beetle has reached the pupal stage, after which it practically ceases as pupae are rarely parasitized. Most of the developing parasitic larvae have completed feeding and spun their cocoons by the middle of August. Some of these (about 20%) pupate immediately after spinning their cocoons; transform to adults, and emerge the latter part of August. The rest of the brood of Coeloides remains in the larval stage within their cocoons until the following spring, when the larvae pupate, transform, and emerge during May and June.

TYPE 2. The main Dm attack begins the first ten days in July, and attacks continue to occur into the first week of September*. As the new attacks are practically continuous, the brood of the beetle can be found in almost all the larval stages after a period of about four weeks has elapsed, and towards the middle of August pupae and rarely callow adults can be found in the earliest attacked trees. The middle of September finds these trees with many callow adults under the bark, and while it is possible that a few of these emerge, indications are that they compose less than 1% of the brood. Thus, separate trees of this type contain overwintering brood in stages of development from probably the egg to the callow adult.

The female parasites begin to oviposite on the developing Dm larvae about the first of August. The developing parasitic larvae finish feeding and spin cocoons usually before cold weather sets in. In some cases it seems possible that a few Coeloides larvae may overwinter without spinning cocoons and spin them instead the following spring. Naked larvae of Coeloides have been found in early spring, though it was not determined whether they later spun cocoons. A few larvae, probably developing from the first eggs laid, pupate immediately after spinning their cocoons and emerge as adults from their cocoons within a week or two after pupation. Data indicate that the amount of brood which emerges the same season as the cocoon is spun is less than 3%. The remainder of the brood overwinter in their cocoons in the larval stage; the larvae pupate in the spring and emerge during May, June,

* See writer's report of November 15, 1930 on the Habits and Sex Ratio of the Mountain Pine Beetle.

and the first part of July depending chiefly on the exposure. About a 20% parasitism was found to occur in trees attacked by Dm in July.

Dm brood in trees attacked after the first of August remained for the most part too small for parasitism by Coeloides that season. Parasitism in August attacked trees was found to be about 2% and all the cocoons were found to be occupied.

Type 3. Parasitism of the brood of Dm the same season as the Dm attack is represented by Types 1 and 2. Type 3 represents parasitism of the brood of Dm the spring following the beetle attack. In this type the parasites work chiefly on the trees that have been attacked by the mountain pine beetle the previous August and September. Since the brood in these trees, as mentioned previously, overwinter in the small larval stage, it is, by the time the Coeloides have emerged from their cocoons, far enough advanced for parasitism. Some parasitism of the brood of Dm no doubt occurs also in the trees attacked the previous July, for though most of the brood is in the callow adult stage by the time the Coeloides are abroad, a few Dm larvae are probably present.

All the larvae of Coeloides in Type 3 have completed development and spun their cocoons by the middle of July. Some of these remain as larvae within their coccons until the following spring, then pupate, transform to adults and emerge; others pupate, transform and emerge as adults within six weeks after spinning their cocoons.

In Dm infested lodgepole pine in Montana about 95% of the brood of Coeloides overwinter as larvae within their cocoons, but in the white pine a much smaller per cent were found to overwinter. The per cent remaining varies considerably. In one tree examined only about 5% of the

brood was left, in other trees slightly more than 80% was found to remain. Just what the factors are that cause the variations could not be determined.

The brood of Dp not parasitized developed to where by the first of July over 90 per cent of them were in the callow adult stage. The callow adults begin to emerge about the end of the first week of July, and start the main summer attack of the mountain pine beetle. However, a few of the callow adults, for some undetermined reason, still remain in the trees; some beetles were found September 15 (the date of the last examination) in trees from which most of the beetles had emerged during July.

In each of the last two types distinguished above, one finds an irregularity in distribution of parasitism. Some trees of each of these two types are heavily parasitized; often parasitism as high as 80 to 90 per cent is found, but other infested trees nearby the heavily parasitized trees show a very small per cent of parasitism, for some as yet unaccountable reason.

Parasitism in a Type 1 tree was fairly high, but not enough observations were made on this type to determine whether the parasitism was equally heavy among other similar trees.

BIOLOGY AND HABITS

ADULT

The past spring the first adult, a female, was found May 12 on a flat of open exposure; on May 14 the parasites, chiefly males were fairly common on the bark of infested trees in the same locality. The following weeks clusters of males were frequently found on the bark of

On trees waiting for the female to emerge. From this time on to the middle of September Coeloides adults could be found on infested trees. Table I below gives the record of emergence from 468 cocoons of Coeloides spum the previous season. The cocoons were collected April 29, 1930, and kept in the laboratory in a plaster of Paris container which was moistened every day.

TABLE I
SHOWING COELOIDES SP. EMERGENCE FROM 468 COCOONS
COLLECTED APRIL 29, 1930, W. WHITE PINE

Date	Male	Female	Total	Per Cent Male	Per Cent Female
May 15	1*	0	1	100.	
16	48	1	49	97.9	2.1
17	29	22	51	56.9	43.1
18	16	10	26	61.5	38.5
19	23	33	56	41.1	58.9
20	14	45	59	23.7	76.3
21	6	37	43	13.9	86.1
22	4	30	34	11.8	88.2
23	0	2	2	0.	100.
24	0	0	0		
25	9	29	38	23.7	76.3
26	5	10	15	33.3	66.
27	2	3	5	40.	60.
28	0	1	1		100.
29	2	9	11	18.2	81.8
30	1	2	3	33.3	66.7
31	0	0	0		
June 1	1	0	1	100.	
5	5	0	5	100.	
7	0	1**	1		100.
Total	166	235	401	41.4	58.6

* First Emergence
** Last Emergence

The above table shows the emergence from cocoons kept in the laboratory. Table II below gives an idea of the development and emergence as it occurred in the field.

TABLE II
SHOWING STAGE AND RELATIVE PROPORTIONS
OF A CONSTANT NUMBER (25) OF BROOD OF COELOIDES AT TIME OF
EXAMINATIONS, PASS CREEK, METALINE FALLS, WN., 1930

Date of Examination	Instar			Adults Within Cocoons	Empty Cocoons
	Larva	Prepupa	Pupa		
May 10	25	0	0	0	0
12*	1	1	26	0	0
12	25	3	0	0	0
14*	0	0	26	2	0
15	6	22	0	0	0
16	2	24	2	0	0
19	1	15	12	0	0
21	2	13	13	0	0
27	0	1 (dead)	27	0	0
30	4	3	20	0	1
June 4	1	3	24	0	0
8	0	1	25	0	2
10	0	2	26	0	0
12	0	0	28	0	0
14	0	0	27	0	1
16	0	1	20	0	7
18	0	1	20	0	7
18*	Practically no Coeloides left in Trees.				
22	0	1	21	0	6
25	0	0	14	5	9
27	0	0	17	10	1
July 2	0	0	9	13	6
5	0	0	0	3	25
7	0	1	0	2	25
9	1	0	0	2	25
11	0	0	0	0	28
14	0	0	0	0	28

* Counts made on flat of warm exposure.

The period of emergence in the field appears to be due to a great extent to the exposure of the trees containing the cocoons. Emergence up Pass Creek, which is in a rather deep canyon was almost a month behind an exposed flat where a good many examinations were made.

After emerging from the tree by chewing through the bark, the female flies to a tree containing brood of Em and crawls over the bark "sounding" with her antennae for the larvae (very rarely eggs are laid

on pupae of Dendroctonus monticolae) beneath, which are detected in all likelihood, by the vibrations caused by the mandibles scraping against the tree tissues when feeding. The parasite does not employ entrance, ventilation, nor exit holes, as a means of getting closer to the larvae or finding better going for her ovipositor, nor, in fact, does the adult ever see the beetle larva on which her egg is laid; nor would she, as experimentation has proved, lay her eggs on an exposed larva however long the two remain together.

When a suitable host is found, the parasite raises the end of her abdomen until the ovipositor is in a vertical position. She then adjusts herself until the tip of the terebra is over the selected larva, sometimes taking several minutes before she appears satisfied with her position, at other times but a second. Next a slight vertical vibration of the abdomen occurs as the ovipositor is worked into the bark. When the female reaches the host she depresses the terebra suddenly, forcing it, perhaps, through the cuticula of the larva. If this is what happens it is not, however, to lay the egg within the larva, since the egg is deposited only on the surface of the larva, frequently even upon the head capsule. No close observations were made on the period required for oviposition through white pine bark, but through lodgepole pine bark the time required varied between 12 minutes the shortest and 50 minutes the longest. The variation in time may be due to the bark thickness, texture, and moisture content, not to mention the differences in the individual insects.

Immediately after the sudden depression of the terebra mentioned above, the female withdraws it, usually wipes it off with her hind legs and goes in search of another victim. The victims selected appear to be the larger larvae, and there are strong indications that the parasite concentrates on the last or the last two instars. However, data at present are insufficient to warrant a positive statement in regard to this point. A parasitized beetle larva, usually within two days after the egg has been laid, becomes inactive and appears as though embalmed or paralyzed (though they show the effect of oviposition after four or five hours), i.e., when stimulated by some object such as forceps, it either shows no signs of life or moves only slightly and ceases movement much sooner than a nonparasitized larva that has been similarly stimulated. In other respects, except for a very slight darkening of the tissues, the parasitized larva does not differ from a nonparasitized one until a great deal of the larval fluid has been sucked out by the parasite, causing the cuticula to collapse. Whether the "paralyzed" appearance is caused by the parasite piercing the larva and injecting a paralyzing fluid, or whether it is due to the mechanical effect of the puncture alone has not been determined conclusively. Experimentation has demonstrated that piercing the cuticle of a beetle larva with a fine needle tends to produce the same effect as piercing with a Coeloides ovipositor; but the larva pierced by a needle frequently blackens, and in many cases shrivels after a few days. On the whole, the needle-pierced larvae do not remain in a state of preservation as well as the Coeloides-pierced larvae. In performing the puncturing operation it is necessary

to shorten the Coeloides ovipositor, as the natural length terebra is too flexible to enable one to pierce the cuticula of the beetle larva with ease. That portion of the ovipositor remaining attacked to the body is the part used in the operation, and on the tip of it there appears a globule of colorless liquid, but whether this fluid is the element that causes this better state of preservation among the Coeloides-pierced larvae has not yet been determined. Nevertheless, it is strongly believed that such is the case, since it is general knowledge that certain other hymenopterous insects paralyze the prey on which they lay their eggs.

Adults collected in the field in Montana have been kept alive in captivity from 16 to 32 days, but the life span of an adult in the white pine type was not determined, nor was the number of eggs laid during the life of a female. A female collected in the field July 10, 1930, was dissected for eggs. One egg ready for laying, three nearly mature, four of lesser development, and possibly two much smaller eggs were found. Several other females were dissected but the above number (10) was the greatest that was found. This is not very helpful for it was not known how many eggs the female had laid before capture, nor how many eggs were present that were too small to be recognized.

INCUBATION PERIOD

It was very much more difficult to secure oviposition of Coeloides in the laboratory the past season than it was the previous seasons in Montana. Only five eggs were secured and none of these

hatched. It is therefore necessary to use the incubation periods for the eggs secured in Montana. This was found to be between 26½ hours to 4 days in the laboratory. Two records of eggs kept under field conditions showed an incubation period for one of 93 hours, the other of 95 hours.

LARVAL DEVELOPMENT

The following notes are also taken from the studies conducted in Montana as no exact work on the larval development was pursued for Coeloides in the white pine type.

The young parasite on hatching crawls about over the surface of the beetle larva, which by this time is thoroughly embalmed, until it finds a suitable spot to feed. The parasite larva is found on any part of the beetle larva except the head capsule through which it does not feed, occurring on the dorsal, ventral, and pleural regions, dephalad as well as caudad. The larva of Coeloides has but vestigial mouth parts, of which the best developed are the mandibles (Plate 4, fig. /a), and with which it apparently punctures the cuticle, sucking up the fluid that exudes therefrom. As soon as feeding begins the growth is rapid, especially in width; consequently, instead of being elongate with nearly parallel sides, it appears, after 8 to 10 days, more or less swelled with the segmentation less distinct. As the parasite larva matures small whitish "fat bodies" develop beneath the cuticle. The earliest recorded appearance of these is three days after hatching, but this is unusually early. When the larva is nearly mature the "fat bodies" assume a slight yellowish cast as does the rest of the

larva. Usually when this becomes marked the parasite larva ceases feeding within a few days. It may spin a cocoon immediately, as is commonly the case; or delay, for some as yet unknown cause, an indefinite period. The shortest recorded elapsed period from the time the egg was laid until a cocoon was spun is 15 days, but larvae under nearly identical conditions were found which did not spin cocoons after 80 days, though no feeding had been done for the preceding 55 or 60 days.

PUPAL DEVELOPMENT

As discussed under the seasonal history, the month in which the cocoons are spun varies with the time the eggs are laid. Generally the cocoons are spun 3 to 4 weeks after the egg is laid.

Pupation normally always occurs within the cocoon. A few days previous to pupation, the larvae change somewhat into what appears to be the prepupal stage. In this stage the body of the larva becomes slightly constricted in the region of the third thoracic and first and second abdominal segments, and response to stimuli seems to be lacking.

Table I indicates that males begin to emerge in numbers in 2 to 3 days before the females. The males from Dm infested lodgepole pine in Montana were also found to emerge earlier than the females. It was felt at that time that the earlier emergence of the males was due to a more rapid developmental rate of the male pupa, or to an ability to pupate earlier in season than the female pupa. Tables 3a and 3b below indicate that such is not the case, in white pine at least.

TABLE 3a
SHOWING PREPUPAL STADIUM
May 1930

Date Prepupa*	Transformed to Pupa	Sex**	Prepupal Stadium Days
May 1	Coll.as pupa	May 13	[illegible]	12 +
1	" " "	4	Male	3 +
1	" " "	6	Female	5
3		6	Female	3
5		8	Female	3
7		8	Female	1
7		9	Female	2
8		10	Female	2
8		11	Female	3
10		11	-	1
10		11	-	1
11		13	Male	2
11		15	-	4
13		15	-	2
				3.14 + Average

* Five cases were observed where the larva transformed to a pupa without an appreciable prepupal form developing.
** Those not designated died before transaformation to the adult stage.

TABLE 3b
PUPAL STADIUM
May 1930

Female Date Transformed to Pupa	Adult	Pupal Stadium Days	Male Date Transformed to Pupa	Adult	Pupal Stadium Days
May 6	14	8	May 4	13	9
6	15	9	10	17	7
8	16	8	11	17	6
8	18	10	11	19	8
9	16	7	13	20	7
10	17	7		Average	7.4
10	18	8			
11	16	5			
11	18	7			
11	20	9			
	Average	7.8			

From the above two tables it is seen that there is very little difference in the pupal stadia between the two sexes, so that some other factor, such as that the males remain a shorter time in their cocoons

after transforming than do the females, may be the cause of the difference in time of emergence.

OTHER HOSTS

Coeloides sp. was also found to parasitize the larvae of Ips vancouveri and Orthotomicus caelatus infesting western white pine.

ECONOMIC STATUS

Unquestionably Coeloides sp. is the most important parasite of the mountain pine beetle in white pine as well as in lodgepole pine. However, the irregularity of parasitism, which may be due to the overlapping in the development of the Dm brood makes it very difficult to recommend a time for artificial control of the brood of the beetle that will not also destroy a good many parasites (Plate 6, fig. 1). If it were possible to treat the infested trees within 3 to 4 weeks after the Dm attack few Coeloides would be destroyed. However, as the main Dm attack extends from early July to the first part of September such treatment would be impractical. The best policy to follow would be to treat the infested trees at a time when it can be done most economically and to leave the trees with very heavy parasitism standing somewhat like seed trees are left in a cutting area. No study has been made on the survival of the Coeloides in their cocoons after the bark has been removed, but it may be possible that control operations in which treating is done by barking does not destroy many parasitic larvae. This is a point that should be investigated.

Table IV summarizes the data on Coeloides parasitism of Dm brood in white pine.

TABLE IV

THE NUMBER OF BENEFICIAL INSECTS PER SQ.FOOT IN WESTERN WHITE PINE ATTACKED BY THE MOUNTAIN PINE BEETLE IN 1929 (1) NEAR METALINE FALLS, WN.

Treatment	Date Examined: Average	No. of Trees	Average Dm.	Brood Coe-loides	Per Cler-ids	Square Mede-terus	Foot Chal-cids	Foot Ceram-bycids
Untreated	6/8	18	46.1	1.52	1.23	3.19	2.32	8.4
Notch girdled (Standing)	5/12	1	108.4	-	1.88	5.00	.06	12.1
	7/14	1	21.0	1.27	.55	.45	.27	7.5
Untrimmed	7/8	1	96.5	-	.80	3.50	.20	1.8
	7/14	1	15.6	-	-	1.77	-	19.8
Trimmed	5/6	1	63.6	.75	.31	3.39	1.75	23.6
	5/13	1	51.6	1.38	.75	2.75	5.50	18.1
	7/7	1	56.3	-	.71	1.57	-	7.0
Trimmed and Cut into Logs	5/8	1	19.9	2.00	1.19	2.62	4.87	19.6
	5/22	1	37.0	1.22	1.44	13.58	16.58	7.4
Trimmed and covered with brush	7/7	1	69.9	-	.38	3.00	-	3.1
	7/7	1	24.1	.44	-	-	.89	18.3

(1) Data taken from the 1930 progress report on the mountain pine beetle in western white pine by A. L. Gibson. Station Report 1931.

Rhopalicus pulchripennis Cwfd.

(Hymenoptera - Pteromalidae)

This species (Plate 4, fig. 2d), while parasitizing less than 1 per cent of the brood of the mountain pine beetle in the lodgepole pine stands in Montana, was fairly common. In the white pine stands on the Kaniksu, no specimens of this genus were collected. Whether the locality was out of the range of the insect or whether some factor was the cause of its absence was not determined.

Its absence is noticeable as it is the only species of pteromalid that, parasitic on the mountain pine beetle in Montana, was not found to be present on the mountain pine beetle in western white pine.

Eurytoma pissodis Gir.

(Hymenoptera - Eurytomidae)
Secondary Parasite

In lodgepole pine stands in Montana, this species (Plate 4, fig. 4d) was found to parasitize about 5 per cent of the larvae of Coeloides sp. There it was reared both from cocoons of Coeloides and from larvae of Coeloides which had been parasitized before spinning their cocoons. In the white pine type on the Kaniksu, the parasitism of Coeloides sp. (if at all) is less than 1 per cent. From 466 cocoons of Coeloides collected for emergence records, not a single parasite emerged, nor was there any emergence from a lot containing 1049 cocoons sent to Mr. J. M. Miller in May, 1930. Collections of larvae from Dm larval cells were rare, since only 3 larvae and one pupa were collected the entire summer. As one can not determine, when collected from a Dm larval cell, whether the larva of Eurytoma was a primary or secondary, it is not known whether they had developed on the larvae of the mountain pine beetle or of the larvae of Coeloides.

Since so little is known of its habits in the white pine type, and it does not appear to be of any value, it will not be discussed further.

Cecidostiba dendroctoni Ashm.
Cecidostiba acutus (Prov.)
Cecidostiba spp.

(Hymenoptera - Pteromalidae)

There are several species of this genus found associated with the mountain pine beetle in white pine. C. dendroctoni appears to be the more common; C. acutus is found associated also with Polygraphus, and probably Scolytus sp.; while those that are represented by Cecidostiba spp. may only be variations of the other two species. However, many of the characters appear distinctive enough to be specifically discussed. As good characters for the separation of the immature stages of each species have not been worked out, the genus will be treated as a whole. Some of the characters that appear to be of value in separating the adults will be mentioned below.

ADULT

The females (Plate 4, fig. 5c) average between 3 and 6.5 mm. in length; the males between 2 and 4 mm. C. dendroctoni is somewhat larger than C. acutus. The general color of the genus follows: Head and thorax, green; abdomen, brownish black; antennae, dark except basal joint which is usually straw-colored; coxae, blackish; the front surfaces only, green; trochanters, tibiae, and tarsi, straw-colored; femora, greenish black except the extremities which are the color of the tibiae. The males of dendroctoni differ in color from the females chiefly by having the base of the abdomen yellowish. C. acutus differs from C. dendroctoni by having the terminal abdominal segment relatively shorter. The stigmal club of the latter (Plate 6, fig. 2c) is about as wide as long, whereas, the

club of acutus is generally more than 1.4 times (usually almost two times) as long (Plate 6, fig. 2F). The other species of Cecidostiba resemble acutus in character of the terminal abdominal segment and dendroctoni in the character of the stigmal club (Plate 6, fig. 2E). The first species are generally smaller and brighter green.

EGG

Not known.

LARVA

The mature larvae (Plate 4, fig. 5) average 6 mm. or less in length; the body is uniformly whitish to grey, no hairs whatever are visible to the unaided eye. Under a microscope the head can be seen to bear several small spines. The mandibles are simple and indistinct.

PUPA

The pupae (Plate 4, fig. 5b) range between 2.1 to 6 mm. in length. The antennae vary somewhat in length according apparently to the species. The antennae of C. dendroctoni always extend from almost to the tip of the wing to slightly beyond the tip. The fore-legs extend almost to the tip of the wings but are never longer than the antennae. This arrangement is practically the same for both sexes.

The antennae of C. acutus extend ½ to ⅔ of the distance to the wing ends; the prothoracic legs generally extend the same distance as the antennae, but occasionally are slightly longer than the antennae. The character for the other "species" of Cecidostiba are about the same as those of acutus.

SEASONAL HISTORY

The first adults were found the latter part of May and could be found from then until the end of the field season. Most of the larvae collected in the field in April pupated and emerged between May 12 and 15, but material reared in the laboratory is generally several weeks in advance of material left to develope under field conditions. The principal parasitism of the brood of the mountain pine beetle, occurs the same season as the scolytid attack, the parasite overwintering in the larval stage. This is somewhat different from the conditions observed in Montana where no larvae were found to overwinter in trees infested with the mountain pine beetle. It is possible that there are two generations in some cases.

The pupal stadium of two females C. dendroctoni was 17 and 19 days; that of a male collected as a recently transformed pupa, 11 days; the stadium for 2 Cecidostiba spp. was 12 and 13 days, but as these were collected as pupae the stadium is no doubt somewhat longer. The pupal period for C. aguturs was not determined.

Pachyneuron eccoptogasteri Ratz.

(Hymenoptera - Pteromalidae)

This species was much more numerous in infested western white pine than in lodgepole pine. No exact figures on the amount of parasitism were secured as the larvae of the various species of the pteromalids cannot be separated in the field.

DESCRIPTION OF STAGES

ADULT

The females (Plate 4, fig. 3c) collected in the white pine type averaged 3.9 mm. in length--maximum, 5.7; minimum, 2.5; the males averaged 1.8 mm. in length--maximum, 3.2; minimum, 1.2 mm. The smaller individuals appear to differ from the larger in some characters, but as no distinct difference in their biology was discovered all are treated under the one species. The head and thorax are dark bronzy green, the antennae of the males are slimmer and relatively longer than the antennae of the females. The coxae are generally shiny blue, the other joints of the legs are straw-colored except the femora which are dark brown.

EGG

The egg is pearly white in color and oval in shape. The length of 8 eggs ranged from .59 mm. to .65 mm.

LARVA

Only one 1st. instar larva was secured. Its length was .58 mm. The surface of the body is covered with rather irregular bands of remarkably minute spines or rugosities. The full-grown larvae (Plate 4, fig. 3) average between 3 to 5 mm. in length, and appear to lack the

bands of spines found on larvae of the first. All larvae are creamy white in color.

PUPA

The pupae are creamy white in color until a short time before pupation when they begin to turn brownish. The average length of 11 female pupae was 3.2 mm.--maximum, 4.3; minimum, 2.0. The average length of 8 male pupae was 2.05 mm.--maximum, 3.5 mm.; minimum, 1.5 mm. The antennae of the female pupae extend less than one-half the distance between the wing bases and the wing extremities; the prothoracic legs extend about three-fourths the distance to the wing ends. The antennae of the male pupae extend from almost to the extremities of the wing ends, to slightly beyond them; the prothoracic legs extend about seven-eighths of the distance to the wing tips.

SEASONAL HISTORY AND HABITS

Males and females were found in abundance June 6 and after that date they could be found the remainder of the season on infested trees. The parasite is fairly common on recently attacked trees. As mentioned in the report for lodgepole pine, the female enters ventilation holes of Dm and oviposites through the sides of the egg gallery.

One egg laid between September 6 and 7 hatched between September 7 and 8. This was the only incubation record secured.

The larval period is not known, but there may be two and perhaps three generations a year. Others require almost a year for development. The parasite overwinters, as far as could be determined, in the larval stage only.

The pupal period for five females ranged between 13 and 17 days. The period for five males ranged between 11 and 17 days.

Pupation occurs beneath the bark in no especially constructed cell. The principal period of pupation for the larvae overwintering occurs between the end of April and the first part of May.

ECONOMIC STATUS

This species, though fairly numerous, did not appear to parasitize sufficient brood of Dm to be considered of much economic value.

Medeterus aldrichi Wh.

(Diptera - Dolichopodidae)

The larvae of this insect are the most valuable predators of the mountain pine beetle in both lodgepole and western white pine, but no method has yet been devised to enable one to determine how valuable they are. It is probable, however, that they destroy much more brood of the beetle than is destroyed by Coeloides, as the eggs of the fly are laid in trees as soon as they are attacked. Though they doubtless destroy more brood, it is questionable whether they are as beneficial as Coeloides.

DESCRIPTION OF STAGES

ADULT

The adult (Plate 3, fig. 26) is a somber grey fly averaging about 4. mm. in length. (There is a slight bluish-green sheen to the body when the light strikes it at certain angles, and the front below the antennae is distinctly blue-green.) The basal joint of the antenna is orange; the second and third segments are black. The thorax is marked dorsally by four greyish-white longitudinal vittae, and the scutellum bears two pairs of bristles. The cubital cell of the wing is short and not pointed. The second segment of the tarsus of the metathoracic leg is not more than twice the length of the first; while in the first two pairs of legs the first joint of each tarsus is longer than the second.

The original description is in the Proceedings of the California Academy of Science, 3rd. Series, Vol. 2:1, pp.24-5, 1899.

EGG

The eggs (Plate 3, fig. 3) are oval in shape and slightly flattened dorso-ventrally; brownish-orange in color, and smooth and shining. Those laid by females in Montana averaged .86 mm. in length and .18 mm. in width; but those secured from females ovipositing in infested white pine in Washington were slightly larger. The average size of sixteen eggs was: length, .91 mm.; width, .21 mm.; maximum length, .99 mm.; maximum width, .25 mm.; minimum length, .81 mm.; minimum width, .18 mm.

LARVA

The first instar larvae are slender, creamy white in color, and average about .7 mm. in length. As far as could be determined they bear the same external characters and are the same color as the full-grown larvae (Plate 3, fig. 9). These larvae average about 8 mm. in length. The characters for distinguishing the intermediate instars were not determined.

The larva is composed of an indistinct head, three thoracic and nine abdominal segments. Antennae, labial palpi, and the buccopharyngeal armature are visible on the head. The dorsum of the first thoracic segment is marked cephalad by a brownish sclerotized plate roughly hemispherical in shape; the dorsum of the second abdominal segment bears a similarly situated but a much narrower sclerotized area. Pseudopods occur ventrally and cephalad on each of the second to seventh (inclusive) abdominal segments. Each pseudopod is armed with a set of locomotor spinules.

Mallock (1) says that some larvae of the Dolichopodidae are peripneustic, and Imms (2) states that the larvae of Medeterus have this type of respiratory system. However, all the larvae of Medeterus that were examined by the writer were amphipneustic, and the anterior pair of spiracles were located in the mesothoracic segment, not the prothoracic segment, as is generally the case with amphipneustic larvae. (3)

PUPA

The pupa (Plate 3, fig. 29) is creamy white in color except for the sclerotized areas, which are brown. The average length is about 4.5 mm. A pair of sclerotized respiratory spines originate directly behind the eyes, and their bases appear to parallel the posterior margin of the eyes beneath the cuticula. A single transverse row of spines is found dorsally on all but the terminal of the last eight body segments. A pair of spiracles or spiracular scars are found on each except the last two of the segments bearing the row of spines. The terminal segment bears a series of 7 to 9 pairs of elongated spines; all but the inner and shortest pair are sharply hooked at the end.

SEASONAL HISTORY AND HABITS

In the white pine type the first adult was found on May 27; in the lodgepole pine type on June 5. After these dates adults were present in the field the remainder of the season.

The imagines are rather ubiquitous, for they were observed on Douglas fir, cedar, western white pine, and lodgepole pine trees whether infested by barkbeetles or green. More extensive search would probably

(1) Mallock, J. H. Preliminary Classification of Diptera, exclusive of Pupipara, based on larval and pupal characters, with keys to the Imagines in certain families. Pt. I. 12:161-407. ill., Bul.III State Lab.1917

(2) Imms, A. D. A General Textbook of Entomology. XII-698, ill. London: Methuen & Co., Ltd., 1925.

(3) See addenda at end of report, Page 65.

have disclosed their presence on other species of trees. Adults were found to be much more numerous, however, on infested trees, and especially so on trees that had been recently attacked by the mountain pine beetle. This was pronounced in one case in the white pine type where, on a tree that had been attacked but two or three days, six or seven adults could be seen to a square foot of bark surface; whereas, on several trees near by that had been attacked about eight days earlier, only two or three adults were observed over an equal area.

The female works over the bark in a rather amusing manner. She appears to glide in an effortless fashion forward, sideward, and backward with equal ease and frequency. Now and then she stops to feel under a bark scale or into a crevise with the tip of her ovipositor. Though she goes through the same actions on green as well as infested trees, no eggs have so far been found on the green trees. On infested trees the eggs are laid singly or in clusters of two or three; no more than three in a group have been found in the field, but in the laboratory as many as nine eggs were laid in a scattered group. The eggs are laid under loose bark scales or in small crevices, never in ventilation or exit holes constructed by the parent mountain pine beetle. If a female Medeterus aldrichi chances upon one of these holes she avoids it by moving to one side or flying off. There are, however, several smaller species of Medeterus, as yet undetermined, which are occasionally found on trees infested by the mountain pine beetle and Ips oregoni Eichh. These, however, have only been observed to oviposite in ventilation or exit holes made by Ips. Unfortunately, nothing is known of their biology.

Though the courtship of some of the Dolichopodidae (3) is very

(3) VanDuzee, M. C., Cole, F. R., and Aldrich, J. M. The Dipterous Genus Dolichopus. U.S. Nat. Mus. Bul. 116, 1921.

elaborate; the courtship, if any, and the mating of Medeterus were not observed.

Mallock (op.cit.) reports the adults feeding on smaller insects, and mentions a similar observation by Perris. The writer in one instance observed a female capture and feed on a small red spider (probably one of the Tetranychidae).

It is not known how many eggs a female lays during her existence. Dissection of a female collected in the field revealed four eggs practically mature and ready for laying; thirty partially formed in one ovary and thirty-one in the other, making a total of sixty-five eggs potentially for one female. This, of course, does not take into consideration the eggs laid before capture or the other eggs that may have developed if she had not been dissected. Females kept in the laboratory and fed on sugar water lived about three weeks; the males usually lived a shorter period.

The eggs hatch after an incubation period of ten to fourteen days. Just before the eggs hatch the larva can be seen through the chorion in a J-shaped position, with the head at the longer end. After hatching, the larvae work their way into the inner bark in search of nourishment. They feed chiefly on the living eggs, larvae, and pupae of the mountain pine beetle, but they will also feed on dead ones, on cerambycid larvae, and on each other. They can not be reared together, for within a few days only one will be left.

An attempt was made to rear the larvae in decaying cambium, and while some lived for nearly a month all died without appreciable growth. It shows, however, that they are capable of living for a considerable period without animal food.

The larvae of Medeterus aldrichi, it seems, find their prey fortuitously. In the field laboratory they have been observed to pass by the larvae of Dendroctonus monticolae and larvae of their own species .1 of a mm. distant, giving no indications of sensing the other's presence. When their prey is found, feeding is done by piercing its cuticle with the lance-like mandibular sclerite, and sucking up the larval juices. It may be well to mention that the mouth is situated on the dorsal surface of the mandibular sclerite.

Under artificial conditions the predators were never observed to consume completely the larva on which they started to feed. Whether it is due, perhaps, to a passing whim, or having had enough nourishment for the time being, they would seldom feed long. In the vial, of course, the partially-consumed larvae would be chanced upon again, fed upon for a while longer until in the end they would be reduced to nothing but their integument. The larvae that have been fed upon for a short time bear the same appearance as those paralysed by the braconid, Coeloides sp. This may explain the fact that in the field larvae of the beetle were observed, on which neither the eggs nor the larvae of the braconid could be found but which looked as though they had been parasitized.

The larvae of Medeterus aldrichi can be found at all times of the year in trees ranging from newly attacked to trees recently abandoned by the mountain pine beetle, but they are most numerous in recently infested trees. The larvae preferring moist conditions under the bark are seldom found in any numbers in trees abandoned by the beetles. The cambium of infested trees usually begins to dry out when the brood is still in the callow adult stage, and by the time the beetles have emerged it is generally extremely dry. The smaller larvae work chief-

ly between the wood and the bark, but the nearly full-grown larvae are often equally numerous in the cambium, where they are entirely concealed.

The larval stadium is not definitely known; while it can be as short as a month, it often occupies ten to eleven months if the winter period of dormancy is included. In any case it certainly appears to be less than a year. Before pupation the larvae generally construct small cells composed of frass and shreds of cambium, and line the inside with a silk-like substance. The cocoons are always in the cambium, but may be either visible or concealed when the bark is removed. Though the cells are not always formed, the larvae always enclose themselves within the silk-like cocoons. Within the cocoons the larvae assume a J-shaped position and remain thus until pupation.

Pupae were found from May 7 to September 12 in the lodgepole pine type; in the white pine type they were found between April 25 and July 19, and probably could have been secured during August and September if a more extensive search had been made. Though the main period of pupation in lodgepole pine was between July 21 and July 19, no definite period of pupation was noted in western white pine.

The stadia of pupae for which the period was definitely known occupied 14 to 17 days. As none of the pupae collected in the field and reared even approached this period, it indicates that seventeen days is the maximum period required for development by this stage.

The terminal spines mentioned in the description of the pupal instar probably serve to anchor the pupal skin to the cocoon, thus enabling the adult to emerge from the pupal exuviae with less difficulty.

OTHER HOSTS

Table I shows the record of collection of larvae of Medeterus from galleries of other barkbeetles or other host trees of the mountain pine beetle.

TABLE I

List of Host Trees and Insect Galleries from which Larvae of the Genus Medeterus have been secured (1)

Date of Collection	Locality	Host Tree	Insect Gallery from which collected
5/4/29	Sula, Montana	Pinus contorta Loud.	Ips oregoni Eichh.
6/23/29	" "	P. albicaulis Engel.	Dendroctonus monticolae Hopk.
6/30/29	" "	P. ponderosa Laws.	" " "
8/22/29	" "	Abies lasiocarpa (Hook) Nutt.	Dryocoetes confusus Sw.
9/19/29	Glacier N.P., Montana	Larix occidentalis Nutt.	Dendroctonus pseudotsugae Hopk.
9/30/29	Coeur d'Alene, Idaho	Abies grandis Lind.	Hylurgops sp.
10/22/29	Lolo Hot Springs, Mont.	Pinus contorta Loud.	Orthotomicus caelatus Eichh.
4/26/30	Metaline Falls, Wn.	Abies grandis Lind.	Scolytus ventralis Lec.
5/3/30	" " "	Pseudotsuga taxifolia (Poir)	Dendroctonus pseudotsugae Hopk.
May, 1930	Coeur d'Alene, Idaho	Pinus ponderosa Laws	Dendroctonus brevicomis Lec.
6/19/30	Metaline Falls, Wn.	Abies grandis Lind.	Dryocoetes confusus Sw.
7/30/30	" " "	Pinus monticola Doug.	D. affaber Mannh. and Polygraphus rufipennis Ky.

(1) Collections from the larval galleries of Dendroctonus monticolae Hopk. in lodgepole pine and western white pine are not included.

ECONOMIC STATUS

To date the writer has been unable to determine the amount of brood of the mountain pine beetle destroyed by the larvae of Medeterus aldrichi. As they move from host to host, it will take a considerable amount of controlled experimentation to determine how many individual eggs, larvae, and pupae each one destroys. The single controlled attempt made to determine the possible amount of brood destroyed by the larvae was unsuccessful. Then, since they do not confine their attacks to brood of the barkbeetle, each larva counted can not be considered to have entirely

maintained itself on brood of the barkbeetle alone, but they do destroy a considerable portion of the brood beginning at an early stage.

Some bark from a western white pine tree that had been attacked by the mountain pine beetle about July 12, 1930, was examined for Medeterus larvae July 26, 1930. In 39 cm. of gallery, 73 egg niches were counted of which 50, or 68 per cent contained beetle eggs. Sixteen first instar larvae of Medeterus were counted either feeding on the eggs or near the empty egg niches. It seems likely that these larvae destroyed all of the missing eggs and would probably have destroyed 40 to 50 per cent of the total number. While this amount is probably greater than the average, it shows that the larvae are very destructive in their early stages. On the average it is probable that not over 40 to 50 per cent of all the brood of the mountain pine beetle is destroyed, though no figures are available for this supposition.

In spite of the high destruction to the brood it is doubtful if it is as valuable a factor in controlling the brood of the beetle as is Coeloides, whose average parasitism is but about 16 per cent. Most of the larvae that Medeterus destroys are in their early stages, and it is possible that they would have died from other causes such as temperature, overcrowding, or other predators or parasites. Most of the larvae parasitized by Coeloides are full grown and nearly ready to pupate, and have survived many of the elements apt to cause their death; thus, their chances of reaching maturity are considerably greater than larvae ready to hatch, or recently hatched from the eggs. A detailed study should be made to establish these values.

Table II gives a general idea of the number of larvae of Medeterus per square foot in lodgepole and western white pine.

TABLE II

AMOUNT OF BROOD OF MEDETERUS ALDRICHI WH. AND DENDROCTONUS MONTICOLAE HOPK. PER SQ. FT.(1)

Host Tree	Year of Attack by Beetle	Period of Examination	No. of Trees Examined	Total No. of sq. ft. of bark examined	Average Mountain pine beetle brood per sq. ft.	Average Medeterus brood per sq. ft.
Lodgepole pine	1928	1929 5/21 to 7/23	34	154	62	2 (2)
Western White pine	1929	1930 5/4 to 7/11	18	163	42	3 (2)
		June 9	2	14	38	10
Western White pine	1930	1930 Sept. 17	1	10	42	9
		" 19	1	11	48	16

(1) Table compiled chiefly from the Mss. reports for 1929 and 1930 by A. L. Gibson, Forest Insect Field Station, Coeur d'Alene, Idaho.

(2) Number of Medeterus concealed in the cambium not included.

In the report of last year (loc.cit) on Coeloides it was shown that spring control in lodgepole pine stands destroys a considerable percentage of the brood of Coeloides, and that control work done in the fall destroys but a small percentage of the brood of this species. Fall control work was therefore suggested as a means whereby the braconid could be fostered. However, the females of Medeterus aldrichi begin to oviposite immediately after the trees of either species have been attacked by the mountain pine beetle, and continue to oviposite to some extent until cold weather sets in. Fall control work will therefore destroy all of the brood of this fly in the treated trees. But spring control operations, as they are instituted before the brood of the fly emerges, des-

troy an equal number of larvae of the fly. Because of this it seems that fall control work is still to be preferred, at least in the lodge-pole pine stands, in spite of the destruction to the brood of Medeterus aldrichi.

This position is taken as neither Medeterus aldrichi nor Coeloides sp., the two most valuable insects in the destruction of the brood of the Dendroctonus monticolae, have been able to prevent outbreaks of this beetle. Artificial control is always necessary if the outbreak is to be controlled before too much timber is destroyed, but a method of artificial control which at the same time will not injure one or both of these beneficial insects is to be desired. As it does not seem possible to preserve the brood of Medeterus aldrichi and it is possible to preserve most of the brood of Coeloides sp. by instituting control measures in the fall, this method seems best.

The conditions in the white pine stands regarding Coeloides sp. are different, but not enough is known of its seasonal history at present to make any definite statements.

Nudobius sp.

(Coleoptera - Staphylinidae)

This rove-beetle, while not very common in Dm infested white pine, is a voracious predator, and feeds on the brood of the mountain pine beetle when the opportunity arises, which, unfortunately is not often. It is probably indiscriminately predatory in habits. This species was not found associated with the mountain pine beetle in lodge-pole pine in Montana.

DESCRIPTION OF STAGES

ADULT

The average length of the adult is slightly over 5 mm. The dorsal surface of the head, prothorax, and abdomen is black; the ventral surface of the thorax is slightly lighter in color; the basal segments of the antennae are rufous, the distal segments darker, and the elytra are very dark reddish brown. All the segments of the legs are light reddish brown.

EGG

The average size of seven eggs was .95 mm. in length and .59 mm. in width. The maximum and minimum sizes were respectively as follows: length, 1.05 mm. and .80 mm.; width, .63 mm. and .50 mm. The egg is roughly oval in shape and the surface has a frosted appearance.

LARVA

The full-grown larvae average about 10 mm. in length. The head is brownish and strongly sclerotized. The dorsum of each of the thoracic

segment is somewhat sclerotized, but that of the first is more than that of the other two. The abdomen is composed of nine segments; its dorsal surface bears many rather coarse hairs. The terminal segment bears a cylindrical pseudopod and a pair of two jointed cerci; the terminal segment of which is slightly less than half the diameter of the basal segment and slightly more than half its length.

PUPA

The pupa (Plate 6, fig. 2) is about 5.5 mm. in length. It is characterized by its wedge-shaped form which is caused by the prothorax being bent at right angles to the long axis of the body and head deflected so that the buccal area faces posteriorally. All the segments are evenly sclerotized, and light yellowish brown in appearance.

SEASONAL HISTORY AND HABITS

The adults and larvae can probably be found during the entire field season, under the bark of trees that have been attacked the previous years. None were observed in trees that had been recently attacked.

In the laboratory the adults fed on the larvae of D. pseudotsugae and on the eggs of Dm. There is no reason to doubt that they will also feed on the larvae of the latter. An adult collected June 18, 1930, lived until July 4, 1930. This seems to be a rather short period, but the adult may have been living for several months before capture and the artificial conditions probably hastened its death.

Eggs were secured in the laboratory on June 17 and 21, and in the field on June 18. It is possible that there is a definite period of oviposition, but it seems more probable that eggs are laid almost all

season. While seven eggs were secured in the laboratory only one hatched, this between July 5 and 6th, showing a possible maximum incubation period of 16 days.

The larval stage was not very common but though the only records of collections are for the latter part of July, it is probable that a more extensive search would have revealed their presence most of the season. The larvae feed avidly on the eggs and larvae of Dm but would not feed on the callow adults. Their growth is rapid. A larva which hatched between July 5 and 6th was 8.5 mm. in length July 17. One moult was observed to occur between July 19 and 20. The larva died on August 22 and had fed during that period on 3 other Nudobius eggs (probably), 15 Dm eggs, one Hylurgops larva, and 7 Dm larvae. The larva was not much larger at time of death than on July 17. No larvae were reared from the egg to the pupal stage, so that the larval stadium is not known. However, the results above would indicate that the larval stage lasts in some cases at least, 45 days.

The pupal stage is found under the bark in no especially constructed cells. The stadium is not definitely known. A pupa collected from a Dm 29 tree July 30, transformed between August 10 and 11, 1931, a maximum period of 13 days. A pupa collected August 26 from a Dm 29 tree transformed between September 1 and 2, 1931, a maximum period of 8 days.

ECONOMIC STATUS

Though this is a predatory insect, it appears to be of no economic value in the control of the brood of the mountain pine beetle.

Quedius sp.

(Coleoptera - Staphylinidae)

This rove-beetle is as predacious on the larvae of the mountain pine beetle as is Nudobius. It was somewhat more numerous the past season than the last mentioned species, and like it, was not found associated with the mountain pine beetle in lodgepole pine. It is not abundant enough to be of economic importance.

DESCRIPTION OF STAGES

ADULT

The adult differs from Quedius longipennis Mann., which is found associated with Dm in lodgepole pine, by its smaller size, darker colored wings covers, and lighter colored femora, tibiae, and tarsi. The average length is about 6 mm., and average width 1.5 mm. at the base of elytra.

EGG

The egg is oval in shape; its surface has the same frosted appearance as the eggs of Nudobius. The average length of three eggs was 1.13 mm.; the average width .56 mm. One other egg measured .94 mm. in length and .47 mm. in width, but as it was measured after it had been in alcohol for many months, it is possible that it had shrunk to some extent.

LARVA

The larva differs from the larva of Nudobius chiefly by the character of the clypeus (Plate 6, fig. 2), which has three teeth of almost equal length, the center tooth being slightly the shorter. In Nudobius the center tooth is considerably the shorter. Each tergum, ex-

cept the last, of the abdominal segments bears a pair of greyish sclerotized plates with the setae arranged as shown in Plate 6, Fig. 2. Nudobius lacks these plates. The length of the mature larva is about 10 mm.

PUPA

The pupa resembles the pupa of Nudobius in general appearance. Only one was secured; this was reared through to the adult stage. Though a drawing was made of the pupa at the time of collection, it has been misplaced so that the characters for this stage can not be given. It measured 4.86 mm. in length.

SEASONAL HISTORY AND HABITS

Adults were found the first week of the field season in Dm '29 trees, but no larvae were observed until the first part of June. Though the adults were not very common, a few could be found most of the field season. They were also found on newly attacked trees in August. The habits of the adults are much the same as those of Nudobius. The following field notes are a partial record of their habits:

Three adults collected June 18, 1930 from Dm '29 tree; 1 Dm pupa added 25; no sign of pupa 26; 2 Dm larvae added 28, larvae being fed on within one minute after being added. One Quedius picked up a Dm larva in its mandibles and lifted it clear of the cambium for several seconds. Several minutes later: 3 Quedius chewing on one Dm larva like a trio of jackals and "fighting" among themselves at times. They raised their abdomens and used them to ward off each other when eating ------.

The incubation period is not known, as none of the eggs hatched. The eggs were laid between June 18 and 25, but it is not likely that

there is a definite period of oviposition.

The first larva was observed in a Dm '29 tree June 4, 1930. Though it died within six days it fed on two Dm larvae during that time. Another larva, collected from a Dm '29 tree June 12, fed on six Dm larvae during the period to July 5; on July 8 it appeared to be approaching the prepupal stage. It remained in that condition one day and pupated the following day, July 10.

No pupae were observed in the field under the bark of beetle infested trees, so pupation may possibly occur in some other portion of the tree. The pupal stadium of the above mentioned individual was between thirteen and fourteen days.

ECONOMIC STATUS

This insect is of no economic importance.

Rhizophagus procerus Csy.

(Coleoptera - Rhizophagidae)

DESCRIPTION OF STAGES

ADULT

The average length of the adult (Plate 1, fig. 1) is about 3.6 mm.; max., 4.2 mm.; min., 3.0 mm. The head and thorax are brown, and the sculpturings of evenly distributed obovate punctures; the antennae are generally lighter in color than the head. The pronotum is generally same color as head but occasionally darker brown. The bases of the elytra are lighter in color than pronotum; while the remaining portion of the elytra generally shades to darker brown towards its apex. Their surfaces are smooth and shining except for eight rows of punctures on each, and the first row is impressed towards the apex. The pygidium is distinctly exposed and punctured.

EGG

The size of the only egg (Plate 2, fig. 4a) secured was as follows: length .61 mm., width .29 mm. Color translucent yellowish white.

LARVA

The length of the first instar larva, from the above mentioned egg, was .98 mm. It resembled the mature Rhizophagus larvae (Plate 2, fig. 4). The mature larvae are about 5.5 mm. long; whitish yellow in color; with no pronounced markings on dorsum of any segment. The terminal segment bears at the apex a pair of fixed cerci hardened only at

the tips; two ocelli at base of each antenna; spiracles indistinct, a pair between the pro and mesothorax and on each abdominal segment.

PUPA

The lengths of two pupae were 3.0 mm. and 4.9 mm. respectively. The latter measurement was made after the pupa had been in alcohol several months and the pupa may have been somewhat distended. Color, white; dorsal surface of head bearing nine bristle-like hairs on each side; each hair arises from a small protuberance; dorsal surface of pronotum bearing 18 similar hairs on each side, set approximately in 4 transverse rows, two with 4 and two with 5 hairs each. The first row is near the anterior margin; the last near the posterior margin of the pronotum. The tergum of each abdominal segment except the terminal bears two bristle-like hairs on each side. The terminal segment bears 5 hairs on each side situated posteriorly, and pair of brownish sharply upturned cerci. This arrangement is taken from but one pupa.

HABITS

This species was found to be more common under the bark of Dm infested lodgepole pine than Dm infested western white pine.

The adults collected from lodgepole pine have been observed to feed avidly on the eggs of the mountain pine beetle; they have also been observed attempting to feed on living Dm pupae. During the time of observation they were not able to pierce the cuticula of the pupa, but the following day about one-third of the pupa had been eaten. In white pine they have been observed feeding on (1) a chalcid pupa; (2) an Acanthocinus larva; (3) a Dm larva; and (4) a Dm pupa, but whether

they had killed these forms could not be determined. It is also suspected that they feed on the [illegible]todes under the bark.

The feeding of the larvae in lodgepole pine was not observed but in white pine they have been observed "ganged-up" feeding on a Dm larva and a Coeloidea larva (through the cocoon); one also was found within a Hypophloeus larval skin.

SEASONAL OCCURRENCE

In lodgepole pine the adults were first observed May 5, and could be found the rest of the season in infested and recently abandoned trees. In western white pine adults were found the first day of the 1930 field season (April 25) in trees containing Dm '29 brood, and in trees which had been killed two years previously. A pair were also observed in copulation April 26 in a Dm egg gallery. Adults could be found the remainder of the season in Dm '29 trees and also in newly attacked trees from 10 days to two weeks after the attack.

As the larva reared from the above described egg resembled a full-grown Rhizophagus larva, it is felt that there is very little question as to the egg's identity. This egg was collected June 7, 1928, from a Dm '28 yellow pine in Montana, and hatched between June 10 and 11. This is the only record secured in two and a half years. Adult beetles were kept constantly in the laboratory the past season, but not an egg was laid.

The first larva in lodgepole pine was observed June 18. In western white pine the first larva was recorded June 4, when two were collected from a Dm '29 tree.

The earliest record of a pupa was June 23. This pupa was reared from a larva collected June 4, but the pupa unfortunately did not transform; the other record of a pupa is one that transformed July 27 from a larva that was collected July 14. This pupa was preserved so that we have no record of the pupal stadium.

The following table shows the occurrence of Rhizophagus procerus in the egg galleries of other barkbeetles:

Date	Locality	Stage	Host Trees	Insect Galleries from which collected
7/8/29	Sula, Montana	A	W. Yellow pine	Dm
7/8/29	" "	A	" " "	"
8/31/29	Polaris, Montana	A	White Bark pine	" & Pityogenes carinulatus
9/14/29	Glacier N. P.	LAA	Engelman Spruce	Ips, Dryocoetes
9/18/29	" " "	A	Western Birch	Dryocoetes
9/30/29	Kneville, Idaho	A	Grand Fir	Hylurgops
9/30/29	" "	A	W. White pine	Pityogenes, Ips, Dryocoetes
10/8/29	Rainier N. P.	A	Engelman Spruce	Dryocoetes, Trypodendron, Hylurgops.
10/22/29	Lolo N. F., Mont.	A	Lodgepole Pine	Orthotomicus caelatus
11/6/29	Coeur d'Alene, Ida.	A	W. White pine	Ips vancouveri
4/28/30	Metaline Falls, Wn.	A	Engelman Spruce	Dm & Trypodendron
4/28/30	" " "	A	Grand Fir	Scolytus ventralis
4/30/30	" " "	A	Alpine Fir	Pityokteines elegans
9/23/30	" " "	A	Aspen	Trypodendron retusus

ECONOMIC IMPORTANCE

While this species in the larval and adult stages will feed on both the eggs and larvae of the mountain pine beetle, they are not sufficiently predacious to search out their prey but instead appear to feed on the first thing they chance upon. There is also little question that they can exist without feeding on brood of Dm and as their opportunities of reaching the brood is very poor, due to the habit of the adult Dm to pack frass around her eggs, and to the type of Dm larval galleries, this species cannot be considered as a valuable predator.

Lasconotus complex Lec.

(Coleoptera - Colydiidae)

This species was not as common in the western white pine stands as it was in the lodgepole pine stands. Very few adults were observed; no larvae, and nothing was learned of its habits in this region. The species is of no economic importance.

DESCRIPTION OF STAGES

ADULT

The adult insect (Plate 1, fig. 5) in white pine does not vary in size or color from those found in lodgepole pine. The average length is slightly over 3.5 mm. The color is a dull uniform Van Dyke brown.

EGG

No eggs were secured for this species in the white pine type. The average length of the eggs (Plate 2, fig. 9a) secured from the insects found in lodgepole pine, was .90 mm. The egg is oval in shape and slightly smaller at one end than the other.

LARVA

The description of the larva is made from ones collected in lodgepole pine.

A first instar larva measured 1.05 mm. in length and in most respects resembled a full-grown larva. It differed from older instars by having relatively larger hairs on the body and by having the terminal plate less strongly roughened and sclerotized. The full-grown larva (Plate 2, fig. 9) averages 5.5 mm. in length; its color is whitish with a brown sclerotized head. The dorsum of the terminal abdominal seg-

ment is strongly sclerotized and roughened, and bears a pair of upturned cerci. The penultimate segment is hardened only in the caudal region and not roughened. Each pleuron bears two long hairs and the spiracles are almost invisible. All the stages observed had five ocelli at the base of each antenna. These are arranged in two rows; the anterior row is composed of three ocelli, the posterior row of two ocelli.

PUPA

The superficial form of the pupa resembles the form of the adult closely enough so that it is easily distinguishable from other pupae. It averages about 3.8 mm. in length.

SEASONAL HISTORY

Because of the scarcity of this species in white pine, very little was determined concerning its seasonal history. Adults were found the first week of the field season (April 25 to May 1) in Dm killed western white pine that had been attacked over a year, and in trees that still contained brood of the beetle. The adults were also found during September in trees that had been attacked in July.

The larval stage was not observed.

ECONOMIC STATUS

This insect is of no economic importance in the control of the brood of the mountain pine beetle in western white pine.

REMARKS

Lasconotus pertenius Csy. resembles L. complex Lec., but can be distinguished from it by its somewhat smaller size and relatively much

greater slenderness. The pronotum is not marked with the sharp ridges that are present in the pronotum of complex, and the ridges of the elytra are less pronounced.

This species is much rarer than complex, only four or five individuals being observed the entire season.

Two other undetermined species of Lasconotus were collected in western white pine, but nothing was learned of their habits or seasonal history.

Hypophloeus parallelus Melsh.

(Coleoptera - Tenebriondiae)

This is a fairly common species found in association with the mountain pine beetle in infested trees. The adults and larvae have been observed in the laboratory to feed on Dm larvae and they probably would act the same under field conditions. It is probable that both stages are facultative predators.

DESCRIPTION OF STAGES

ADULT

The average length is about 4.0 mm.; the width 1.5 mm. The color is a uniform medium to dark brown. The surface of the head, thorax, and elytra is shining, and rather uniformly covered with small shallow punctures. See Plate 1, Figure 3.

EGG

The size of six eggs averaged between 1.03 mm. and .90 mm. in length, and .39 mm. and .36 mm. in width. The shape (Plate 2, fig. 8a) is oval but rather blunt at each end; color: whitish, opaque, and slightly shining.

LARVA

The full-grown larva (Plate 2, fig. 8) is about 7 mm. in length, and composed of 13 segments, including the head. All the terga are brownish and sclerotized more caudad. There are no conspicuous hairs or bristles on the body; the terminal segment lacks cerci. The earlier stages resemble the full-grown larvae except in size.

PUPA

The pupae average somewhat over 4 mm. in length; are yellowish

white in color, and unlike the larvae bear a pair of cerci or cerci-like appendages on the terminal segment.

SEASONAL HISTORY AND HABITS

Adults and larvae were fairly common April 25, 1930, under the bark of trees containing brood of the mountain pine beetle and trees abandoned by the beetle the year previous. One pupa was also found April 25 in a Dm '28 tree. In Dm '29 trees adults could be found the entire season, and in Dm '30 trees within a week after the attack of the beetle. Larvae were present in Dm '30 trees three weeks after the attack, though no pupae were observed in any of the trees attacked the past season.

While 3 eggs were secured, their incubation period was not determined, as no sign could be found of the eggs four days after they had been laid. The eggs had been left in the vial with the parent adults, and it is probable that they consumed them as they did the Dm larvae placed in the vial. However, one egg collected in the field May 12 hatched between May 15 and 16.

In lodgepole pine no records were secured to show that Hypophloeus larvae would feed on Dm larvae, but the following notes made August 22, 1930 show that the larvae are occasionally predacious.

"One healthy and active Dm larva added to vial containing several H. p. larvae collected from Dm 29-2 tree August 18, and which had not been fed since collection. The Hypophloeus larvae were inactive when the Dm larva was added; but it had been in only a few seconds when they began to crawl about actively in the general direction of the Dm larva. The first one that reached the larva immediately began to chew on it--but when two other Hypophloeus larvae started in the Dm larva twitched its abdomen up-

wards and sideways. The Hypophloeus larvae were "chased off" but within 5 minutes two of them were observed feeding on the one Dm larva. The other Hypophloeus larva was not feeding and made no attempt to feed.

The period required for the larvae to reach the pupal stage was not determined but it probably requires nearly a full season. Callow adults, pupae, and apparently full-grown larvae were observed in a Dm '29 tree September 6, and it is likely that these larvae developed from eggs laid that spring.

This species is parasitized by a braconid parasite, Meteorus n. sp.

ECONOMIC STATUS

Though predacious in the larval and the adult stage, no indication was secured that the species are of any importance in reducing the brood of the mountain pine beetle. Both stages are probably facultative, feeding on living animal matter if it is chanced upon or supporting themselves on vegetable or dead animal matter when nothing else is available. It is possible that they at times maintain themselves on nematodes.

Hypophloeus glaber Lec.

(Coleoptera - Tenebrionidae)

This species was more abundant in western white pine in some Dm '28 and '29 trees than H. parallelus, but it was never found in Dm '30 trees. It appears, however, to be associated with a wider range of bark-beetles than H. parallelus. These species are also found in infested lodgepole pine in Montana.

While there is some indication that the adults will feed on Dm larvae, the results are not conclusive enough to justify the statement that they are facultative.

The only other record of this insect, as listed by Leng, is from Florida, so it seems possible that the insect discussed here may not be glaber, especially so as Dr. Van Dyke considers it a new species. The specific determination was made by Mr. Fisher of the U. S. National Museum. (1)

DESCRIPTION OF STAGES

ADULT

The adults (Plate 1, fig. 2) average about 3 mm. in length and 1 mm. in width. The prothorax is generally darker (often nearly black) brown than the rest of the body. The dorsal surface of the body is rather closely and evenly sculptured with small round punctures; between the punctures are many minute rugulations, which give the body a dull appearance. The legs and antennae are somewhat lighter in color than the rest of the body.

EGG

Eight eggs averaged .73 mm. in length; max. .75, min. .67 mm., and .30 mm. in width; max. .31, min. .29 mm. The shape and color are similar to the shape and color of the eggs of H. parallelus.

(1) See addenda Page 65, second paragraph.

LARVA

The larvae are similar in appearance to the larvae of H. parallelus, and no salient character was found to separate the two species. The mature larvae of H. glaber, however, are never as large as the mature larvae of H. parallelus.

PUPA

Not known.

SEASONAL HISTORY AND HABITS

Adults were found the first day of the field season (April 25) in Dm '28 and '29 trees, and could be found the remainder of the season in trees attacked before July, 1930. No adults were observed in Dm '30 trees.

The habits of the adults were not conclusively determined. They have been observed feeding on Dm larvae, but it was not possible to determine whether they had killed the larvae or whether the larvae had died from some other cause before being fed on. Though Dm eggs placed in a vial with the adults often disappeared, actual feeding was not seen. An adult collected June 18 remained alive until August 18; during this entire period one Dm larva was added on July 11. The Dm larva remained alive until July 15, when no sign of it could be found. This indicates that the adults are probably facultative predators.

The eggs are probably laid under the bark along the sides and in the egg galleries of Dm, where the bark is loose and rather moist. Of five eggs laid in the laboratory between July 14 and 15, four hatched between July 19 and 20; the remaining eggs probably hatched between July 22 and 23, but as only four larvae could be found it is possible that the remaining egg may have been destroyed by one of the recently hatched larvae.

One of these larvae lived until October 8, and attained a length of about 2.5 mm. It was placed in cold storage October 8, with some other living material, but when removed and examined January 8, 1931, it was dead.

A comparison of the larvae of H. glaber and H. parallelus revealed no characteristics that could be used to separate the small larvae of the two species. There can be little doubt, however, that the larvae about 7 mm. long are parallelus and not glaber. Since glaber could not be separated from parallelus, the feeding habits of the first mentioned species could not be determined in the field. While no actual feeding was observed in the laboratory, Dm eggs that were placed with the larvae of H. glaber usually disappeared within two or three days.

OTHER HOSTS

Date Collected	Locality	Host Tree	Host Gallery
5/8,20/29	Sula, Montana	Lpp.	Dm.
6/27/29	" "	"	"
8/25/29	" "	"	Ips oregoni
4/30/30	Metaline Falls, Wn.	A. lasiocarpa	Pityokteines elegans
6/19/30	" " "	" "	Dryocoetes confusus
8/26/30	" " "	A. grandis	Scolytus ventralis
9/22/30	" " "	P. monticola	Polygraphus rufipennis
			Dryocoetes affaber

ECONOMIC STATUS

This species is of no appreciable economic importance in the biological control of the mountain pine beetle.

Acanthocinus (Graphisurus) *obliquus* Lec.

(Coleoptera - Cerambycidae)

In infested western white pine, the larvae of this species are much more common than in infested lodgepole pine. The larvae in feeding consume practically everything in their path and thus where numerous, are often directly destructive to the brood of the mountain pine beetle. It is also probable that they destroy some larvae indirectly by lessening the food supply.

DESCRIPTION OF STAGES

ADULT

The adults (Plate 5, fig. 13) in western white pine ranged between 10 and 12.5 mm. in length (to the end of the elytra); those found in lodgepole pine in Montana were practically the same size. The head, thorax, and abdomen are mottled greyish black; the antennae are alternately banded with grey and black, and the elytra are mottled grey and black.

EGG

Not observed.

LARVA

The full-grown larva averages about 22 mm. in length. They can be easily distinguished from the larvae of Monochamus, with which they are frequently associated, by the forward projection of the head and by the bisection of the antennal ring by the frontal suture. The head of Monochamus is deflexed and the antennal ring is not bisected by the frontal suture.

PUPA

The pupa (Plate 7, fig. 2A) is about 19 mm. in length and white

in color. The antennae are long and after attaining the lower half of the abdomen curl back towards the head. The terminal portion of the abdomen of the pupae examined was attenuated. Whether the pupae examined were all females was not determined, but the elongated region looked much like the extruded ovipositor.

SEASONAL HISTORY

Not a great deal was learned of its seasonal history. Adults were observed during July on recently attacked trees, but they were not numerous. One small larva was observed in a 1930 attacked tree in August. On September 8 larvae were still present both between the wood and the bark and in the wood in trees from which adults were reared in July; no pupae were observed. This may indicate either that some individuals require two seasons to reach maturity or that eggs are laid in the same trees from which the adults emerged. During May, June, and part of July, larvae were very abundant (Plate 7, fig. 1) in trees attacked the previous year. In 1930 the average number was about 5 per square foot for the standing trees.(1) while it appeared to be slightly higher in some of the felled trees the variations in data were too great to justify drawing conclusions.

The larval period appears to be about 10 months. Pupation in the infested trees occurred during June and July either under the bark in a frass-constructed cell (Plate 7, fig. 2 A & B) or in the wood to a depth of about an inch.

The following table summarizes the data secured concerning the pupal stadium.

(1) Gibson, A. L. Progress Report on Mountain Pine Beetle, Western White Pine, 1930. March, 1931.

THE PUPAL STADIUM OF ACANTHOCINUS OBLIQUUS
IN WESTERN WHITE PINE

Date Collected	Stage	Date pupated between	Date emerged between	Period in days
June 3, 1930	Pupal	-	June 18 & 19	16
" " "	"	-	" 22 & 23	20
June 17, 1930	Larval	June 25 & 27	July 13 & 14	19
" " "	"	" " "	" " "	19
" " "	"	" " "	" " "	19
" " "	"	June 27 & 28	" " "	17
" " "	"	June 29 & July 1	July 14 & 15	16
" " "	"	July 2 & 3	" " "	13

NATURAL ENEMIES

The larvae are preyed upon by the larvae of Xylophagus abdominalis, and are parasitized by a species of Atanycolus apparently near rugosiventris Ashm. Adults of the latter species were observed the forepart of June on trees containing Acanthocinus larvae, and Atanycolus larvae were observed the same time. The parasitic larva resembles the larva of Coeloides sp. in general appearance, but grows to a considerably greater size and spins a peculiar flattened cocoon (Plate 5, fig. 1) with a distinct beading (like that of a pill box) around the top and bottom at the edges. The cocoons which were common August 26, are brownish white in color and ranged from 8.5 to 14 mm. in length; 3 to 5 mm. in width, and 1 to 2 mm. in thickness.

There appears to be a single generation a year; the larvae winter over in their cocoons and pupate some time during the spring.

ECONOMIC STATUS

While there are often more Acanthocinus larvae than mountain pine beetle larvae per square foot of bark, they do not seem to be of any great value in reducing the brood of the barkbeetle. This may be due, to some extent, to the seasonal development of the insects, but on the whole, the development of the larvae of the two species appears to be about equal.

This insect does not appear to be destructive enough to be considered of much economic value in the control of the barkbeetle in western white pine.

BIBLIOGRAPHY

No mention is made in the text of the publications listed below. While not a very complete list of writings they are given as they were found to be the most helpful and it is hoped that some of them may be of use to other workers. The contents in most cases are suggested by the titles, but where not, it is indicated after the journal of publication. *Indicates that the publications have not been seen but would probably be of value.

Ashmead, W.
1900 Classification of the Ichneumonoidea. Proc. U.S.N.M. Vol. 23 #1206.

Ashmead, W.
1904 Classification of the Chalcid Flies of the Chalcidoidea. Mem. Carnegie Mus. 1:4.

Blackman, M. W.
1915 Habits and Observations on Pityogenes hopkinsi Sw. N. Y. S. C. F. Tech. Bul. #2. 16:1. pp.53-56. Deals also with the parasites and predators of Pityogenes.

Blackman, M. W. & Stage, H. H.
1924 I On the Succession of Insects Living in the Bark and Wood of Dying, Dead, and Decaying Hickory. Tech. Pub. 17. 24:22..

Bornebusch, C. H.
1930 The Fauna of Forest Soil. Privately printed for Ph.D. degee. State Forest Experiment Station, Springforbi, Denmark.

Boving, A. G.
1929 On the Classification of Beetles According to Larval Characters. Bul. Brooklyn Ent. Soc. Vol. 24 No. 2. pp.55-60

Boving, A. G. & Champlain, A. B.
1921 Larvae of N. A. Beetles of the Family Cleridae. Proc. U.S.N.M. Vol. 57 #2323 P.575.

Burgess, A. F. & Crossman, S. S.
1929 Imported Insect Enemies of the Gypsy and Brown Tail Moth. U. S. D. A. Tech. Bul. #86.

*Burke, H. E.
1917 "Parasites of Buprestis laeviventris?". Proc. Ent. Soc. Wn. 19: p.87.
1919 "Parasites of Buprestis laeviventris?". Proc. Ent. Soc. Wn. 21: p.124.

Caffrey, D. J.
1921 The Biology and Economic Importance of Anastatus semiflavidus Gahan, A Recently Described Parasite of Hemileuca oliviae Ckll. Jour. Agr. Res. 21:6.

Carr, F. S.
1920 New Species of Lonchaea. Canadian Ent. 52:8.

Chapin, E. A.
1915 Early stages of Staphylinidae. Psyche. 22:157.

Chittenden, F. H.
1909 The Fruit-tree Barkbeetle (S. rugulosus Ratz.). U.S.D.A. Div. Ent. Cir. #29. Mention is made of several associated insects including Rhizophagus and Cheiropachus.

Clemens, W. A.
1916 The Pine Barkbeetle. Cornell Agr. Exp. Sta. Bul. #383, Itaca, N. Y. Deals with Ips pini Say. and gives history, Synonymy and list of supposed parasites and predators.

Cushman, R. A.
1926 Some Types of Parasitism among the Ichneumonids. Proc. Ent. Soc. Wn. 28:1. pp.29-51. 5 pls. 1 fig.

Cushman, R. A.
1927 The Parasite of the Pine Tip Moth - Rhyacionia. Jour. Agr. Res. 34:7. April 1. Key to all species.

Cushman, R. A. & Schwer, S. A.
1920 Tribes of the Ichneumonidae (Pimplinae). Proc. U.S.N.M. #2315 Vol. 57. pp.379-396.

Gahan, A. B.
1922 A list of Phytophagous Chalcidoidea with Descriptions of Two New Species. Proc. Ent. Soc. Wn. 24:2.

Gahan, A. B.
1925 Rhopalicus pulchripennis Cwfd. Proc. U.S. Nat. Mus. 65 art. 4:15.

Gibson, A. L.
1929 Progress Report on Mountain Pine Beetle. #3 Mss. March 15, 1929.

Girault, A. A.
1917 New Chalcid Flies with Notes. Bul. Bklyn. Ent. Soc. Vol. XXI. pp.86-89.

Green, C. T.
1926 Descriptions of Larvae and Pupae of ... the family Leptidae. Proc. U.S.N.M. Vol. 70 art. 2. pp. 1-20. #2651.

Kleine, R.
1908/9 The European Barkbeetles and their Enemies in the order Coleoptera and Hymenoptera. Ent. Bl. IV & V.

Mallock, J. R.
1915 North Am. Pachygasterinae. Annals. Ent. Soc. of Am. Dec. 8:4. Describes species of Neopachygaster. See Zebrachia.

Mallock, J. R.
1917 Preliminary Classification of the Larvae and Imagines of the Orthorrhapha. Bul. Ill. State Lab. Vol. XII Art. III. March.

Mank, Helen G.
1923 Biology of the Staphylinidae. Ann. Ent. Soc. Am. 16:3 p.220.

Merrill, J. H. & Ford, A. L.
1926 Life History and Habits of two New Nematodes Parasitic on Insects. Jour. Agr. Res. 6:3. p.115.

Muesebeck, C. F. W. & Dohanian, S. M.
1927 A Study in Hyperparasitism, with Particular Reference to the Parasites of Apanteles melanoscelus (Ratz.). U.S.D.A. Bul.1487.

Nelson, J. A.
1924 Morphology of the Honeybee Larva. Jour. Agr. Res. 28:12 pp.1167-1213.

Parker, W. L. & Thompson, W. R.
1925 Notes on the Larvae of Chalcidoidea. Ann. Ent. Soc. Am. 18:3.

Patterson, J. E.
1928 Studies of the Mountain Pine Beetle in Lodgepole Pine and Other Studies Conducted in Southern Oregon in 1927. Mss. Palo, Alto, Calif.

Parson, H. L.
1928 A Study of the Clerid Thanasimus nigriventris Lec. with Notes on other Insect Enemies of the Western White Pine Beetle. Mss. Palo Alto, Calif.

Phillips, W. J. and Poos, F. W.
1921 Life History Studies of three joint worm Parasites. Jour. Agr. Res. 21:6. pp.405-426.

Pierce, W. D. & Cushman, R. A.
1915 A Few Notes on the Habits of Parasitic Hymenoptera. Proc. Ent. Soc. Wn. 17:164-167.

Rohwer, S. A. & Gahan, A. B.
1916 "The Horismology of Hymenopterous Wings". The wing veination terminology employed by R. and G. Proc. Ent. Soc. Wn.18:1 pp.20-76.

Smith, H. S.
1926 Importance of Life History Data in Biological Control. Jour. Ec. Ent. 19:5.

Smith, R. C.
1922 The Biology of the Chrysopidae. Cornell Uni. Agr. Exp. Sta. Mem. 58.

Snodgrass, R. E.
1911 The Thorax of Hymenopters. Proc. U.S.N.M. 39.

Struble, G. R.
1930 The Biology of Certain Coleoptera Associated with Barkbeetles in Western Yellow Pine. Uni. Calif. Pub. in Ent. 5:6.

Taylor, R. L.
1929 The Arthropod Fauna of Coniferous Leaders Weeviled by Pissodes strobi Peck. Cont. from the Ent. Lab. of the Bussey Institute. Psyche #301 35:4.

Taylor, R. L.
1929 Biology of the White Pine Weevil, Pissodes strobi (Peck), and A Study of Its Insect Parasites from an Economic Viewpoint. Ent. Americana 9:4 and 1930 X:1.

Thompson, W. R.
1922 On the Taxonomic Value of Larval Characters in Tachinid Parasites. Proc. Ent. Soc. 24:4.

Thompson, W. R.
1923 A Criticism of the "Sequence" Theory of Parasitic Control. Ann. Ent. Soc. of America. 16:2.

Thompson, W. R.
1929 On the Relative Value of Parasites and Predators in the Biological Control of Insect Pests. Bul. Ent. Res. 19: pt. 4 pp. 343-350, March.

Thompson, W. R.
1930 The Biological Control of Insect and Plant Pests. Report.... on Progress of Work at Farnham House Laboratory. London. Printed by His Majesty's Stationery Office, June. 124 pp.111.

*Thompson, W. R.
1930 Entomophagous Parasites and Phagocytes. Nature 125 No. 3144. (London).

*Thompson, W. R.
1930 The Principles of Biological Control. Ann. App. Biol. 17:2 pp. 306-338.

*Thompson, W. R. & Parker, H. L.
1928 Contribution a la Biologie des Chalcidiens entomophages. Ann. Soc. Ent. Fr. 97:425-465.

Thompson, W. R. & Parker, H. L.
1930 Morphology and Biology of Eulimneria crassifemur (Thomson), an Important Parasite of the European Corn Borer. Jour. Agr. Res. 40:4.

Tothill, J. D.
1922 The Natural Control of the Fall Webworm in Canada. Dept. of Agr. Bul. #3 N.S. Ent. Bul. #19.

Townsend, C. H.
1908 A Record of Results from Rearings and Dissection of Tachinidae. U.S.D.A. Bur. of Ent. Tech. Ser. 12 pt. VI.

Trimble, F. M.
1924 Habits of Two Pacific Coast Barkbeetles. (Ips plastographus and I. radiatae). Am. Ent. Soc. Am. Dec. 17:4.

Van Duzee, M. C.
1919 Key to the N. A. Species of the Dipterous Genus Medeterus, with Descriptions of New Species. Proc. Calif. Acad. Sciences. 9:8 pp.257-270.

Van Dyke, E. C.
1915 Some New Ostomidae and Cleridae from California. Bul. Brooklyn Ent. Soc. April Vol. X #2.
Key to species of Corticotomus and Nemosoma.

Van Dyke, E. C.
1926 The Value of Life History Studies from the Viewpoint of Systematic Entomology. Jour. Ec. Ent. 19:5.

Wadsworth, J. T.
1915 On the Life History of Aleochara bilineata. Jour. Ec. Biol. 10:1-27.

Watson, K. B.
1928 Bionomics of the Spruce Barkbeetle. Sci. Ag. 8:10. June. Mention of several parasites is made.

Wheeler, Esther W.
1923 Some Braconids Parasitic on Aphids and their Life History. Ann. Ent. Soc. Am. 16:1; p. 1. Gives also a summary of Larval forms of many hymenoptera other than Braconidae, and a bibliography but no titles.

Wilson, J. W.
1930 The Genitalia and Wing Veination of the Cucujidae and Related Families. Ann. Ent. Soc. Am. 23:2.

ADDENDA

After this report was typed a letter received from Mr. C. T. Greene of the U. S. National Museum, contained some information on Medeterus, which shows that what was considered the first thoracic segment of the larva is really a subdivision of the head so that the first sclerotized plate is on the caudal portion of the head, not the first thoracic segment as stated on Page 29 of this report. Thus, the larva is composed of a head and eleven body segments, and the prothoracic segment not the mesothoracic segment bears the anterior pair of spiracles.

Hypophloeus glaber Lec. (page 54) is listed by L. J. Farmer of the University of Idaho in his thesis (1931), "Studies in Fire-Injured Yellow Pine Trees, Pinus ponderosa Laws." from Moscow, Idaho. This species was determined by Dr. Frank E. Blaisdell.

Explanation of Plates

The number following the genus or species, or on the other plates the number following the stage, is the length in millimeters of the specimens from which the drawings were made: the figures in parentheses after the family name refer to the plate and number respectively, which show drawings of another stage of the species mentioned. Drawings made by the aid of the camera lucida. Photographs of drawings made by H. J. Rust.

Adult Coleoptera - Plate I

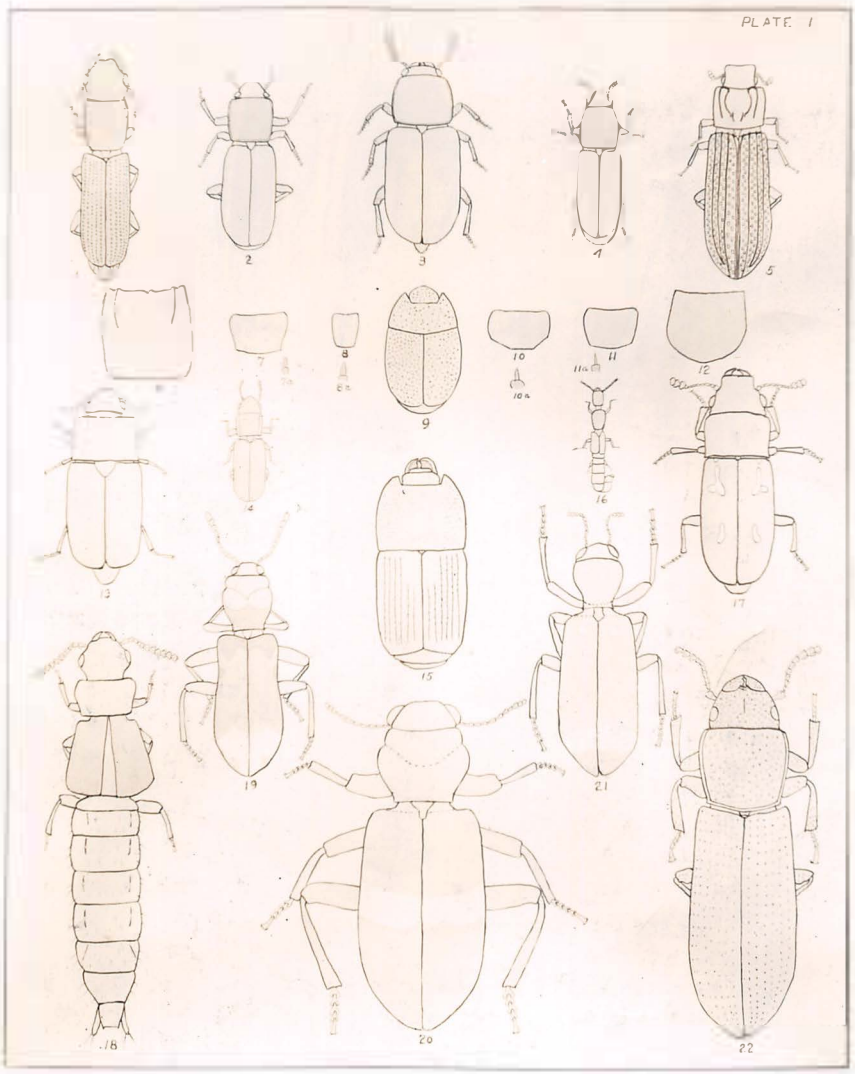
Fig. 1 *Rhizophagus procerus* Csy. - 4.2 Rhizophagidae (2-4)
2 *Hypophloeus* n. sp.? 3.6 Tenebrionidae
3 " *parallelus* Melsh 4.0 " (2-8)
4 " n. sp.? 3.3 "
5 *Leaconotus complex* Lec. 4.2 Colydiidae (2-9)
6 *Aulonium longum* Lec. (*pronotum* 1.5) "
7 *Phloeonomus punctipe* Grav.(*pronotum* 1.5) Staphylinidae (2-2)
(see also Fig. 18)
7a " " " Terminal segment of maxillary palpus.
8 *Tlesaia* sp. Staphylinidae
8a " " Terminal segment of maxillary palpus
9 *Isolomalus* sp.? 2 Histeridae
10 *Placusa* sp. Staphylinidae
10a " " Terminal segment of maxillary palpus.
11 *Leptusa* sp. Staphylinidae
11a " " " " " " palpus.
12 *Quedius longipennis* Mann (*pronotum*) Staphylinidae
13 *Tarpus Inaequalis* Melsh. 3.6 Nitidulidae (2-6)
14 *Laemophloeus angustulus* Lec. 2.0 Cucujidae
15 *Platysoma punctatum* Lec. 3.9 Histeridae (2-7)
16 *Nudobius cephalus* (Say)? 10.6 Staphylinidae (2-11)
17 *Glischrochilus vittatus* (Say) 4.7 Nitidulidae (2-1)
18 *Phloeonomus punctipe* Grav. 2.2 Staphylinidae (2-2)
19 *Thanasimus dubius* Lec. 6.2 Cleridae (2-3)
The darkest areas indicate red, the lightest, grey, and the medium shade, grey-black or black.
20 *Enoclerus sphegeus* Fab. 9.5 Cleridae (2-3)
The lighter shade indicates a grey band which is generally wider and rather variable in width.
21 *Enoclerus lecontei* (Wolc.) 7 Cleridae (2-3)
The lighter areas indicate grey; the band towards the apex of the elytra is generally wider and attains the tip.
22 *Temnochila virescens* (Fab.) var. *chlorodes* (Mann) 11 Ostomidae (2-2 and 4)

Explanation of Plates

The number following the genus or species, or on the other plates the number following the stage, is the length in millimeters of the specimens from which the drawings were made: the figures in parenthesis after the family name refer to the plate and number respectively, which show drawings of another stage of the species mentioned. Drawings made by the aid of the camera lucida. Photographs of drawings made by H. J. Rust.

Adult Coleoptera - Plate 1

Fig. 1	Rhizophagus procerus Csy. -	4.2	Rhizophagidae (2-4)
2	Hypophloeus n. sp.?	3.6	Tenebrionidae
3	" parallelus Melsh	4.0	" (2-5)
4	" n. sp.?	3.3	"
5	Lasconotus complex Lec.	4.2	Colydiidae (2-9)
6	Aulonium longum Lec. (pronotum 1.5)		"
7	Phloeonumus pusillus Grav. (pronotum 1.5)		Staphylinidae (2-2) (see also fig. 18)
7a	" " " Terminal segment of maxillary palpus.		
8	Eleusis sp.		Staphylinidae
8a	" " Terminal segment of maxillary palpus		
9	Isolomalus sp.?	2	Histeridae
10	Placusa sp.		Staphylinidae
10a	" " Terminal segment of maxillary palpus.		
11	Leptusa sp.		Staphylinidae
11a	" " " " " " palpus.		
12	Quedius longipennis Mann (pronotum)		Staphylinidae
13	Epurea linearis Makl.	3.6	Nitidulidae (2-6)
14	Laemophloeus angustulus Lec.	2.0	Cucujidae
15	Platysoma puntigerum Lec.	3.9	Histeridae (2-7)
16	Nudobius cephalus (Say)?	10.6	Staphylinidae (2-11)
17	Glischrochilus vittatus (Say)	4.7	Nitidulidae (2-1)
18	Phloeonomus pusillus Grav.	2.2	Staphylinidae (2-2)
19	Thanasimus dubius Lec.	6.2	Cleridae (5-3)
	The darkest areas indicate red, the lightest, grey, and the medium shade, grey-black or black.		
20	Enoclerus sphegeus Fab.	9.5	Cleridae (5-3)
	The lighter shade indicates a grey band which is generally wider and rather variable in width.		
21	Enoclerus lecontei (Wolc.)	7	Cleridae (5-3)
	The lighter areas indicate grey; the band towards the apex of the elytra is generally wider and attains the tip.		
22	Temnochila virescens (Fab.) var. chlorodea (Mann)	11	Ostomidae (5-2 and 4)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Coleopterous Larvae and Pupae - Plate 2

Fig. 1	*Gitechrochilus vittatus* (Say)	Larva 9.5 Nitidulidae (1-17)
1a	" " "	Egg
1b	" "	Arrangement of ocelli
1c	" "	Detail of cerous
2	*Phloeonomus punctipe* Grav.	Egg Staphylinidae
3	*Tachyporus* sp.	Larva 2.7
4	*Rhizophagus probably procerus* Say.	" 5.4 Rhizophagidae (1-1)
4a	" *procerus* Say.	Egg .6
4b	" probably *procerus* Say.	Detail of terminal segment
4c	" " "	Arrangement of ocelli
5	*Pytho* probably *planus* Herbst?	Larva 9; for pupa see Fig.10(5-15)
5a	" " " "	Arrangement of ocelli
6	*Tenebroides Linearis* Melsh.	Larva 4.5 Nitidulidae (1-15)
6a	" " "	Arrangement of ocelli
7	*Platysoma punctigerum* Lec.	Larva: detail of head and first 2 thoracic segments (1-15)
7a	" "	Detail of terminal segment
8	*Hypophloeus parallelus* Melsh.	Larva 6.5 Tenebrionidae (1-3)
8a	" " "	Egg .8
8b	" " "	Arrangement of ocelli
9	*Laemophloeus complex* Lec.	Larva 5.5 Colydiidae (1-5)
9a	" "	Egg
9b	" "	Detail of cerous
9c	" "	Arrangement of ocelli
10	*Pytho* probably *planus* Herbst.	Pupa 12; for larva see Fig. 5 (5-15)
11	*Nudobius* probably *cephalus* (Say)	Larva 7.5 (1-16)
12	*Cucujus clavipes* Fab. var *puniceus* Mann.	Pupa 17 (5-1 and 1a)
13	*Canthocris* sp. total length of larva 11.5 detail of head and thoracic segments 4.5	
14	*Malachius* sp.	Larva 4.9

Coleopterous Larvae and Pupae - Plate 2

Fig. 1	Glischrochilus vittatus (Say)	Larva 9.5 Nitidulidae (1-17)
1a	" "	Egg
1b	" "	Arrangement of ocelli
1c	" "	Detail of Cercus
2	Phloeonomus pusillus Grav.	Egg Staphylinidae
3	Tachyporus sp.	Larva 2.7
4	Rhizophagus probably procerus Csy.	" 5.4 Rhizophagidae (1-1)
4a	" procerus Csy.	Egg .8
4b	" probably procerus Csy.	Detail of terminal segment
4c	" " "	Arrangement of ocelli
5	Pytho probably planus Herbst?	Larva 9; for pupa see Fig.10(5-15)
5a	" " " "	Arrangement of ocelli
6	Epurea linearis Makl.	Larva 4.5 Nitidulidae (1-13)
6a	" " "	Arrangement of ocelli
7	Platysoma punctigerum Lec.	Larva; detail of head and first 2 thoracic segments (1-15)
7a	" "	Detail of terminal segment
8	Hypophloeus parallelus Melsh.	Larva 6.3 Tenebrionidae (1-3)
8a	" " "	Egg .8
8b	" " "	Arrangement of ocelli
9	Lasconotus complex Lec.	Larva 5.5 Colydiidae (1-5)
9a	" "	Egg
9b	" "	Detail of cercus
9c	" "	Arrangement of ocelli
10	Pytho probably planus Herbst.	Pupa 12; for larva see Fig. 5 (5-15)
11	Nudobius probably cephalus (Say)	Larva 7.5 (1-16)
12	Cucujus clavipes Fab. var puniceus Mann.	Pupa 17 (5-1 and 1a)
13	Cantharis sp. total length of larva 11.5 detail of head and thoracic segments 4.3	
14	Malachius sp.	Larva 4.9

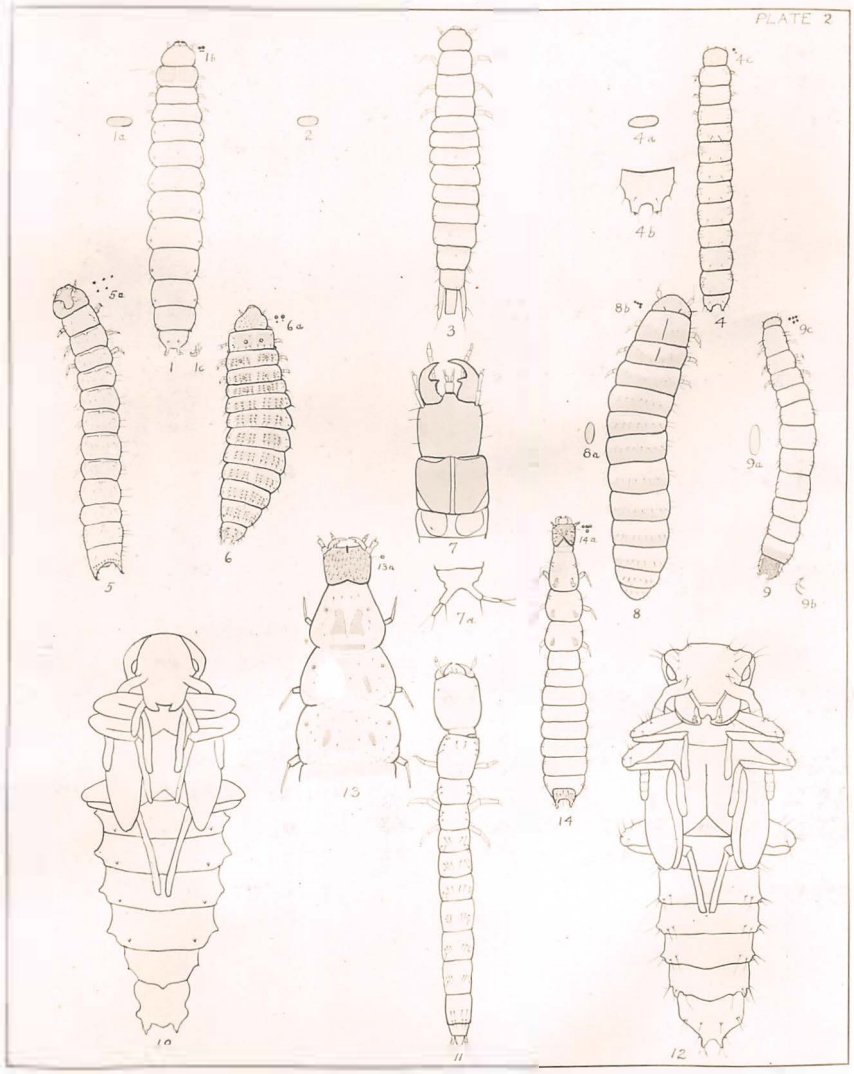
PLATE 2
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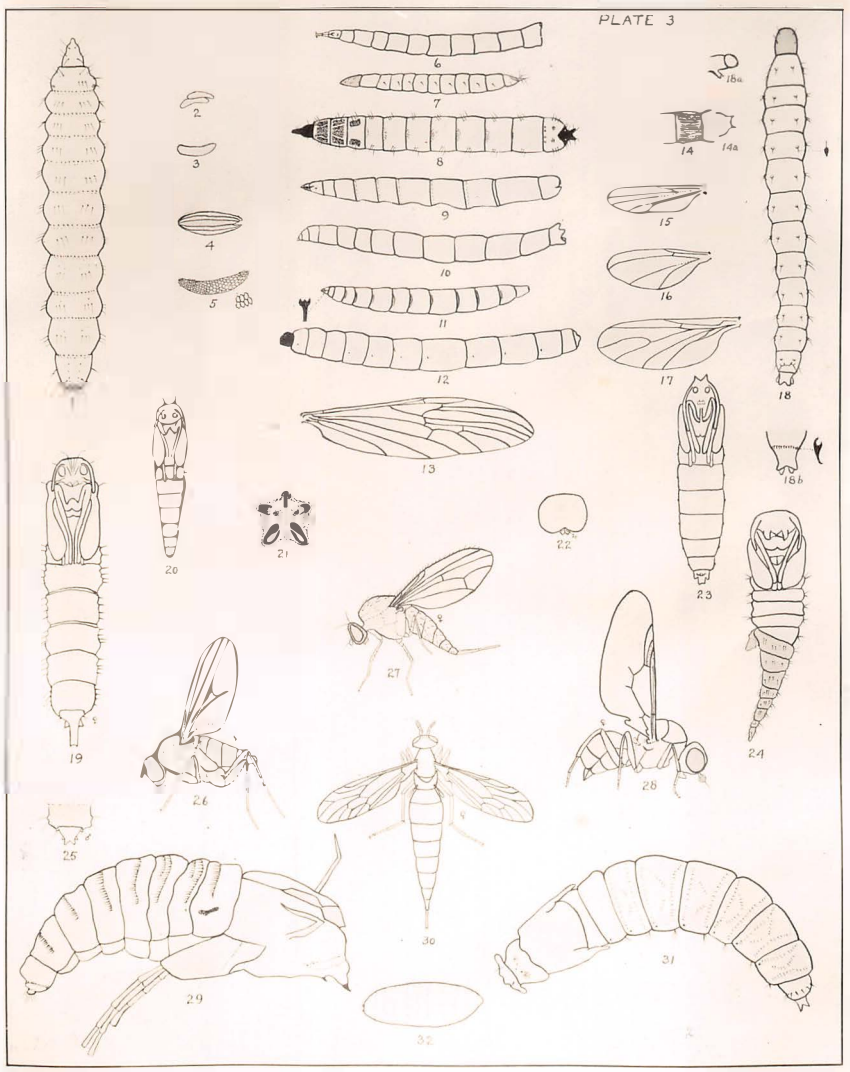
Diptera - Plate 3

Fig. 1	Neopachygaster sp.	Larva 6.3 Stratiomyidae
28	" "	Adult 2.5
2	Lonchaea viridana Meigen	Egg .8 Lonchaeidae
6	" " "	Larva 7
27	" " "	Adult 4.1
32	" " "	Pupa 4.5
3	Medeterus aldrichi Wheeler	Egg .8 Dolichopodidae
9	" " "	Larva 6.5
22	" " "	" terminal segment dorsal view
26	" " "	Adult 4
29	" " "	Pupa 4
4	Gnophomyia tristissima O.S.	Egg .56 Limnobiidae
10	" " "	Larva 9
13	" " "	Wing of adult
19	" " "	Pupa female 8.9
21	" " "	Apical segment of larva caudal view, after Malloch.
25	" " "	Pupa male, apex of abdomen
5	Xylophagus abdominalis Loew	Egg 1.5 Xylophagidae
7	" " "	First instar larva (lateral view)
8	" " "	Mature larva (dorsal view) after Greene.
30	" " "	Adult 12
31	" " "	Pupa 16 (lateral view)
11	Cecidomyidae	Ventral view showing detail of spatula
		Larva 4 Cecidomyidae
16	"	Wing of adult 2
20	"	Pupa 2.7
12	Sciara	Larva 4.1 Sciaridae
17	"	Wing 2.7
23	"	Pupa 4.0
14	Cecidomyidae	Undetermined species distinct from #11 and showing one segment of body and striate appearance of cuticula.
14a	"	Terminal segment of same species showing caudal spines.
15	Forcipomyia probably squamipes Coq.	Wing 1.9 Ceratopogonidae
18	"	Larva 3.4, dorsal view showing detail of tips of dorsal hairs.
18a	"	Larva lateral view showing detail of pseudopod.
18b	"	Larva ventral view of terminal segment showing ambulatory hooks.
24	"	Pupa 2.6 showing cast larval skin which almost invariably adheres to caudal end of pupa.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Hymenoptera - Plate 4

Fig. 1	Coelopides sp.	Larva nearly mature 3.8 Braconidae
1a	" "	Head capsule; mn mandibles
1b	" "	Egg 1.1
1c	" "	First instar larva 1.3
1d	" "	Cocoon 4.9
1e	" "	Adult female. 7 The antenna is shown foreshortened; 2c, 2nd cubital; st stigma
2	Rhopalicus pulchripennis Cwfd.	Larva 3.3 Pteromalidae
2a	" " "	Head capsule
2b	" " "	Pupa 2.9
2c	" " "	Egg
2d	" " "	Adult female 4.2
3	Pachyceras eccoptogasteri Ratz.	Larva 4.1
3a	" " "	Head capsule
3b	" " "	Pupa 3.2
3c	" " "	Adult female
3d	" " "	Antenna
4	Eurytoma pissodis Gir.	Larva 4.1 Eurytomidae
4a	" " "	Head capsule
4b	" " "	Egg .6
4c	" " "	Pupa 4.3
4d	" " "	Adult female 5.0
4e	" " "	Antenna, female
4f	" " "	" male
4g	" " "	Abdomen of male
5	Cecidostiba dendroctoni Ashm.	Larva 5.5 Pteromalidae
5a	" "	Head capsule
5b	" "	Pupa 5.4
5c	" "	Adult female 6.5
6	Haydenia hubbardi Ashm.	Adult female 3.2 Chalcididae
6a	" "	Antenna of female
6b	" "	Abdomen of male
7	Dendrosoter n. sp.	Adult female 4.5 Braconidae
7a	" "	Antenna of female
7b	" "	Egg

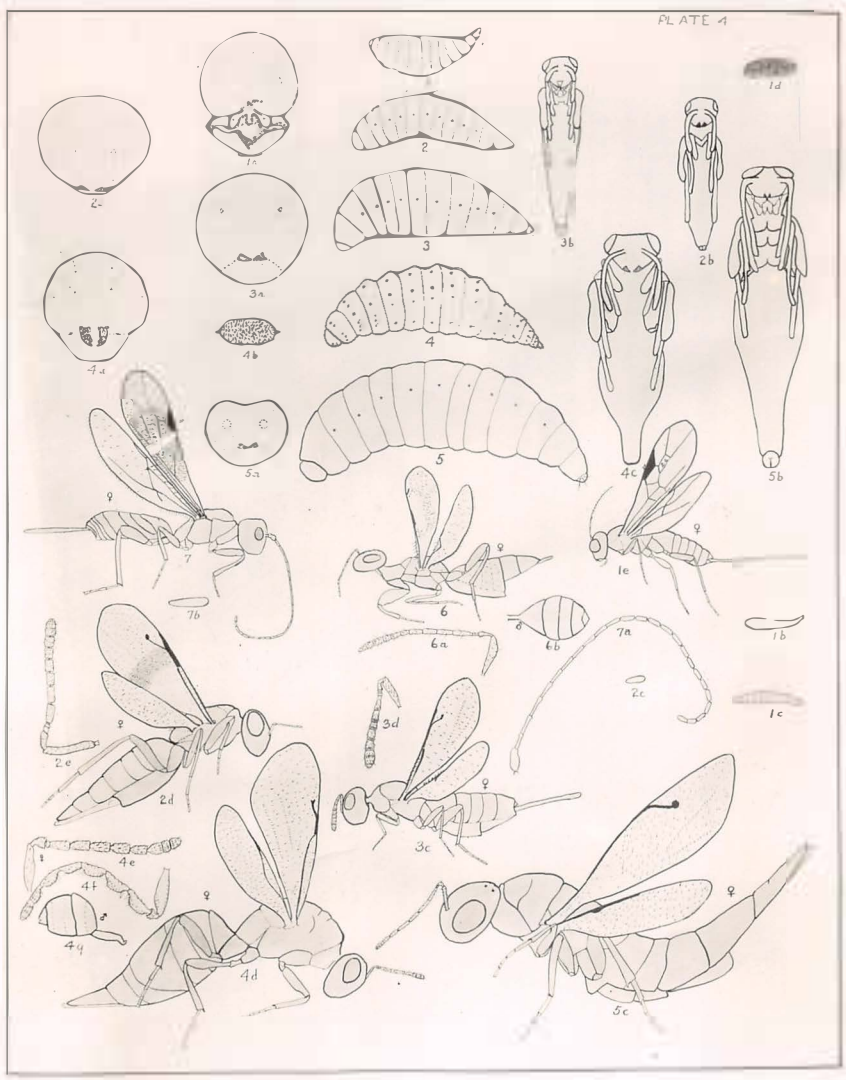
PLATE 1
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Miscellaneous Coleoptera, Hymenoptera and Neuroptera - Plate 5

Fig. 1 Cucujus clavipes Fab. var puniceus Mann. Larva 24 Cucujidae (2-12)
1a " " " " " " Adult 16.5 " (2-12)

2 Temnochila virescens (Fab.) var chlorodea (Mann) Larva 24 Ostomidae (1-22)
Arrow points to undivided area of darkening on 2d thoracic segment.
2a Temnochila virescens var chlorodea Larva 18

3 Clerid larva 19.5 type for Thanasimus and Enoclerus. Cleridae (1-19, 20 and 25)
Arrow points to divided areas of darkening on 2d thoracic segment.

4 Rhaphidia? sp. Larva 14.5 Neuroptera Raphidiidae

5 Stenocorus linsatum (Oliv.) Pupa 14.5 Cerambycidae

6 Buprestid larva 20.5 mm. type for Figs. 16 and 17 Buprestidae

7 Cerambycid larva 22.5 " " " 9-14 incl. Cerambycidae

8 Asemum atrum Lec. Adult 15 Cerambycidae

9 Anthophilax mirificus Bland. female adult 18.5 Cerambycidae

10 Spondylis upiformis Mann. Adult 14 "

11 Xylotrechus undulatus (Say) " 15 "

12 Anthophilax mirificus Bland. " 14.8 Male "

13 Acanthocinus obliquus Lec.? 9.5 "

14 Pogonocherus propinquus Bland. Male 6.2 "

15 Pytho planus Herbst. Adult 13.5 Pythidae (1-5 and 10)

16 Buprestis alternans (Lec.) Adult 19 Buprestidae

17 " maculiventris Say var. rusticorum (Kby) adult 21 Buprestidae

18 Xerus spectrum race caudata Konow. Sircidae Adult 15.5

18a " " " " " " Adult 27.5, same species as 18 but showing diversity in size.

19 Sirex californicus Ashm. Adult 22.5 Siricidae.

Plate 5

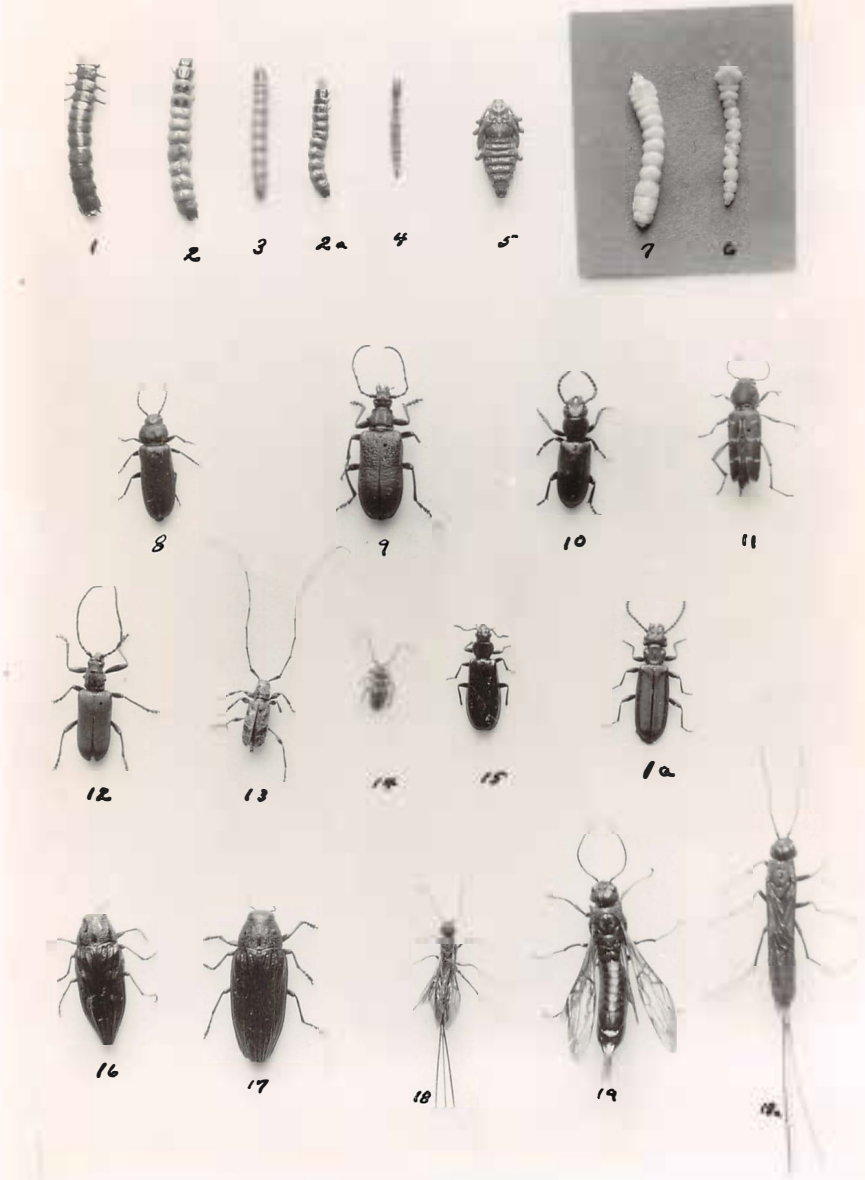
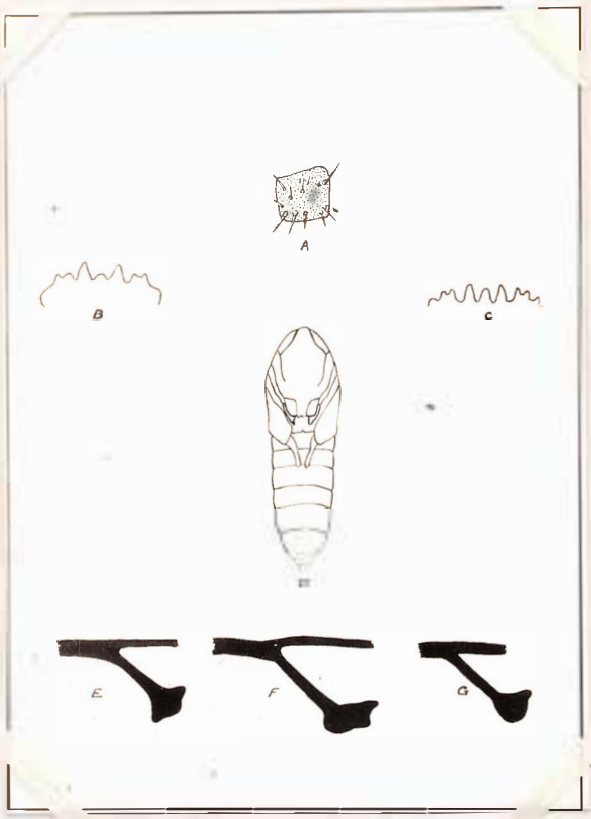


Plate 6, Fig. 2.



A. 5th right tergal plate of Quedius sp.
B. Clypeus of Nudobius sp; C.-Quedius sp.
D. Pupa of Nudobius sp.
E,F,G. Stigmal veins of Cecidostiba sp; C. acutus and C. dendroctoni respectively.

Fig. 1.
Cocoons containing larvae of Coeloides sp. in western white pine June, 1930. These would be destroyed by control work done between September and July.

PLATE 7

Fig. 1.
Acanthocinus obliquus larvae in western white pine.

Fig. 2.
Acanthocinus obliquus in western white pine
A - Pupa; B - Prepupa in chip cocoon.

Plate 8

Fig. 1.
Cocoons of *Atanycolus* near *rugosiventris* Ashm.